LEVEL II

DELAWARE RIVER BASIN

WANGAUM FALLS DAM

NDI Number PA-00141

DER Number 64-102

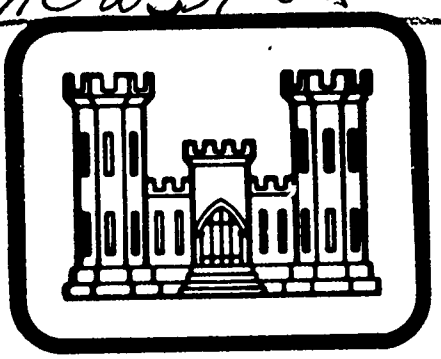
Delaware River Basin

WAYNE COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

(15) DACW31-80-C-0019



PREPARED FOR

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

(12) 104

BY

Berger Associates, Inc.

Harrisburg, Pennsylvania

(11) MARCH 1980

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PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS AND RECOMMENDATIONS

Name of Dam:	WANGAUM FALLS DAM
State & State No.:	PENNSYLVANIA, 64-102
County:	WAYNE
Stream:	WANGAUM CREEK
Date of Inspection:	October 25, 1979

[cont'd from p. i]

Based on the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in fair condition.

In accordance with the Corps of Engineers' evaluation guidelines, the size classification of this dam is small and the hazard classification is high. The recommended Spillway Design Flood (SDF) is the Probable Maximum Flood (PMF). The spillway capacity is inadequate to pass the PMF peak inflow without overtopping the dam. The ~~project~~ dam is capable of passing 70 percent of the PMF, and is considered to be inadequate, but not seriously inadequate.

The following recommendations are presented for immediate action by the owner:

1. That a professional engineer, experienced in the design and construction of dams, review the stability of the spillway walls. His recommendations for improvement should be implemented immediately.

2. That the seepage in the downstream area be monitored on a regular basis. If a volume of flow increase is detected or if a discoloration is noticed, immediate steps should be taken to correct this condition.

3. That all brush and weed growth be removed from the embankment and in an area 20 feet beyond the downstream toe and that this maintenance be repeated on a regular basis.

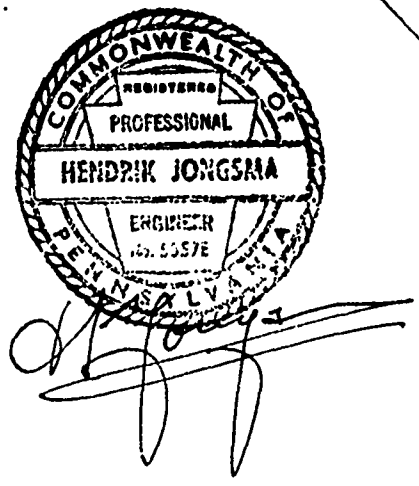
4. That a formal surveillance and downstream warning system be developed for implementation during periods of heavy or prolonged rainfall.

5. That a program be developed for regular maintenance and inspection of the dam and its appurtenant structures.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

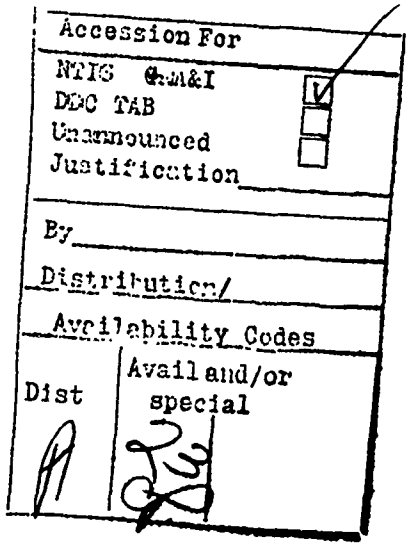
DATE: March 10, 1980

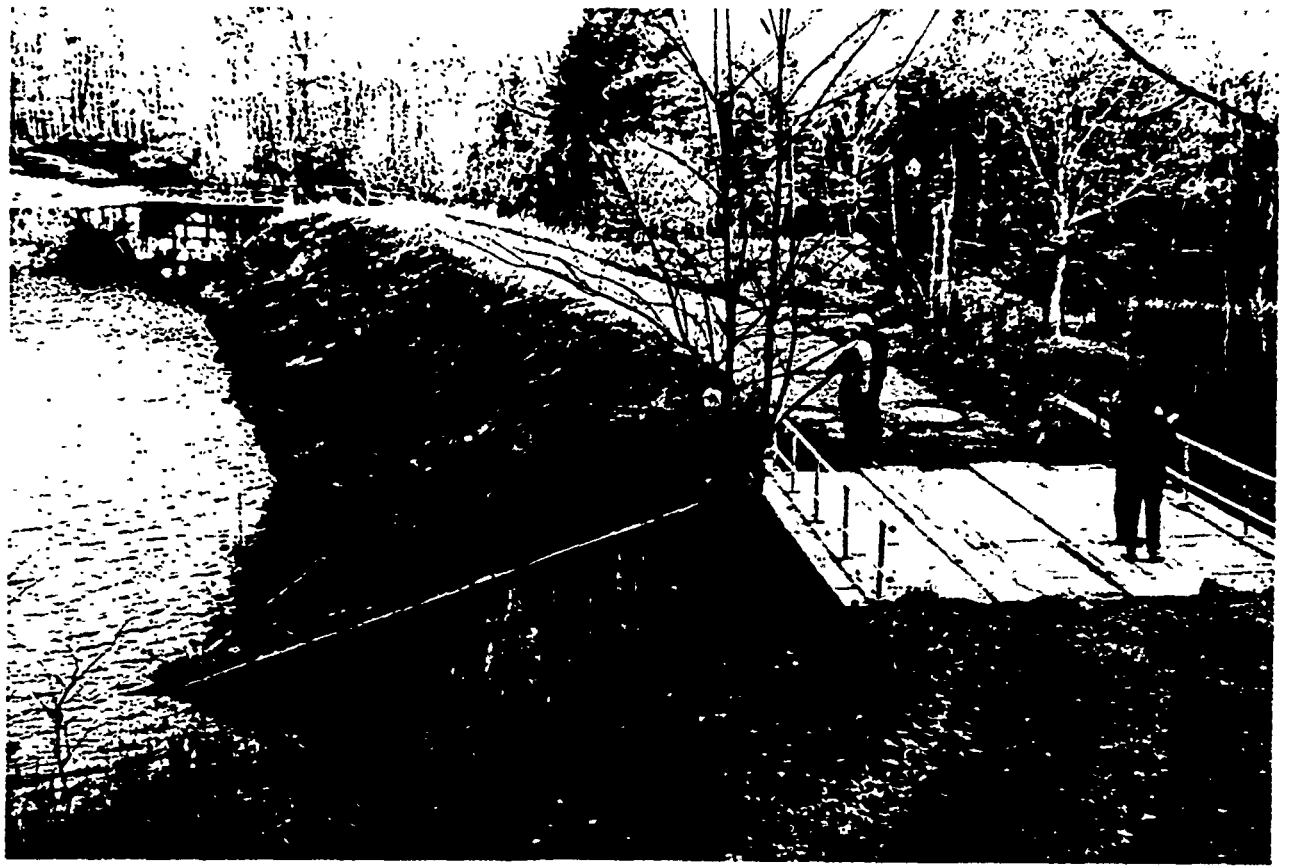


APPROVED BY:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

DATE: 25 March 1980





OVERVIEW

WANGAUM FALLS DAM

Photograph No. 1

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

WANGAUM FALLS DAM

NDI-ID NO. PA-00141
DER-ID NO. 64-102

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose of this inspection is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

Note: Project spillway crest elevation is 1193.25 (Appendix E, Plate IV). The U.S.G.S. Quadrangle shows a reservoir elevation 1057.00. This elevation is used in this report as the top of spillway crest.

Wangaum Falls Dam is an earthfill dam with an embankment length of 310 feet and a maximum fill height of 30 feet. The structure has two spillways. One at the left abutment, which is the old spillway, has been reconstructed and raised several times. The second spillway was added in 1956 and is located in the right abutment. Both spillways have a bridge for vehicle access to a home on the right bank of the reservoir. The left spillway has a vertical slot closed off with vertical boards (stoplogs). Removal of these boards could lower the reservoir to about 7 feet below spillway weir elevation. There are no other drawdown or control facilities for this dam. Heavy riprap protects the upstream slope and a stoned surface roadway is on top of the embankment. The embankment was breached several times by floods prior to the reconstruction in 1956.

[Cont'd on p. 1-2]

B. Location: Paupack Township, Wayne County
U.S.G.S. Quadrangle - Hawley, Pa.
Latitude 41°-29.6", Longitude 75°-15.0"
Appendix E, Plates I & II

C. Size Classification: Small (Height 30 feet
Storage 784 acre-feet)

D. Hazard Classification: High (Refer to Section 3.1.E)

E. Ownership: Wangaum Falls Association
c/o Mr. Edwin Thomas
991 Maple Avenue
Honesdale, PA 18431

F. Purpose: Recreation, private lake.

G. Design and Construction History

The first dam constructed at this site was a mill dam with an unknown date of construction. This dam was 13 to 16 feet high and 290 feet long. A breach occurred at the left end which caused draining of the reservoir. In 1925, a Mr. Kuhn requested a permit to close the breach with a spillway, consisting of a masonry wall six feet thick. The upstream section of this wall was cemented and an earthfill backing was placed on the upstream side. The spillway was 50 feet long and had a weir elevation 4 feet below the top of the dam. A permit was granted and the spillway was completed in 1926. On August 18, 1955, a breach occurred during a flash flood. Plans for repair were drawn up by Mr. L.F. Burlein, P.E., Honesdale, Pa., and a permit for repair was issued on February 29, 1956. These plans included the raising of the embankment and the addition of a second spillway in the right abutment. The contractor for the repairs was Sherman Putman and the work was supervised and inspected by the Design Engineer. The work was completed in November 1956.

H. Normal Operating Procedures

Since the reservoir is used for recreation, a pool level at the spillway crest elevation is maintained. All inflow above this level is discharged over the spillways. The reservoir can be lowered seven feet, if required, for maintenance work. The owners have cabins and homes around the reservoir.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

From files:	8.7
Computed for this report:	8.4
Use:	8.4

B. Discharge at Dam Site (cubic feet per second)
See Appendix D for hydraulic calculations

Maximum known flood, August 18, 1955, inflow estimated on basis of U.S.G.S. gage on Middle Creek near Hawley	2008
Outlet works low-pool outlet	None
Right spillway capacity at pool Elev. 1069.1 (low point of dam)	3415
Left spillway capacity at pool Elev. 1069.1	5219
Total spillway capacity	8634

C. Elevation (feet above mean sea level)

Top of dam (low point)	1069.1
Top of dam (design)	1070.0
Spillway crest - Left	1057
- Right	1056.8
Upstream portal invert (stoplog opening)	1050.4
Downstream portal invert	None
Streambed at centerline of dam - estimate	1039

D. Reservoir (miles)

Length of normal pool	.7
Length of maximum pool	.9

E. Storage (acre-feet)

Spillway crest (Elev. 1057)	169
Top of dam (Elev. 1069.1)	784

F. Reservoir Surface (acres)

Top of dam (Elev. 1069.1)	70.2
Spillway crest (Elev. 1057)	32.8

G. Dam

Refer to Plates III and IV in Appendix E for plan and section.

Type: Earthfill.

Length: 310 feet.

Height: 30 feet.

Top Width: Design: 14 feet.
Survey: 12 feet.

Side Slopes: As surveyed: Upstream - 1.8H to 1V
Downstream - 2H to 1V

Design: Both slopes - 2H to 1V

Zoning: Unknown.

Cutoff: Unknown.

Grouting: Unknown.

H. Outlet Facilities

Stoplog opening located near the center of the left spillway.

Invert: 1050.4

Width: Top = 6.5'
Bottom = 1.3'

I. SPILLWAY

Left Side

Type: Uncontrolled broadcrested weir.

Length: Total length of 50.3 feet divided into 6 bays by concrete piers 1.5 feet wide at bottom.

Bridge: Steel I beam vehicular bridge with wooden plank deck spans the spillway and is located at the upstream edge of the crest.

Crest Elevation: 1057

Right Side

Type: Uncontrolled ogee weir with sloping upstream face.

Length: 25'

Crest Elevation: 1056.8

J. Regulating Outlet

See Section 1.3.H.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Hydrology and Hydraulics

Engineering data on the hydrologic and hydraulic design for these facilities were limited to statements in Reports on the Applications for Repairs. These reports were prepared by the Pennsylvania Department of Environmental Resources (PennDER) or its predecessor, the Water Supply Commission.

The spillway constructed in 1925 in the left abutment had a capacity of 308 cfs based on a 4 foot depth, 50 foot length and a C-factor of 3.27. The drainage area was calculated as 7.5 square miles at that time. Additional discharge capacity was considered to be available in the low portion of the embankment at the right, because this section had a downstream vertical masonry wall. The dam withstood the flood of 1942, but breached in August 1955, due to overtopping of the low embankment. The raising of the embankment and the construction of a second spillway increased the total discharge capacity to 8700 cfs.

B. Embankment and Appurtenant Structures

Design data on the embankment are not available. Letters and reports in the PennDER files indicate that the embankment had steep slopes (1H to 1V) prior to 1955. A typical section on Plate III, Appendix E, indicates slopes of 2H to 1V and a 4 foot deep cutoff trench at the upstream toe. The only available design data for the appurtenant structures are the construction drawings prepared in February 1956 (Appendix E).

2.2 CONSTRUCTION

The available construction data is limited to two letters from Mr. Burlein who was the design and supervising field engineer. Blasting was used for excavation at the right spillway. Immediately after construction, leakage existed at this point and was attributed to fissures in the subsurface rock strata. The embankment was constructed 1.5 feet higher than the design elevation. The concrete of the existing wingwalls of the left spillway was of such poor quality that new wingwalls had to be constructed in 1956, rather than extending the existing walls.

2.3 OPERATION

There are no formal records of operation maintained by the owners. All inflow above the normal pool elevation is discharged over the spillways.

2.4 EVALUATION

A. Availability

The only engineering data available for examination for this dam is located in the files of PennDER. The information is limited to the three drawings reproduced in Appendix E and some application and inspection reports.

B. Adequacy

The available information contained in the PennDER files, combined with a visual inspection are considered sufficient for making a reasonable assessment of the structure.

C. Operating Records

Formal operating records are not maintained for Wangaum Falls Dam. Reports of repairs indicate that the dam failed prior to 1925, was overtopped at a low section in the embankment in 1942 and was breached in August 1955.

D. Post Construction Changes

There are no records of changes since the reconstruction of 1956 was completed. The visual inspection indicates, however, that tilting abutment walls of the left spillway had been strengthened with deadman anchors.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of the Wangaum Falls Dam is fair. It has two spillways: one at the left abutment and one at the right abutment. The crest of the earthfill embankment and the upstream slope were in good condition. Brush cutting on the downstream slope is required. There is a wet area to the left of the right spillway, partially caused by seepage, partially due to poor drainage. The walls of both spillways show considerable cracking and some tilting.

The visual inspection check list and sketches of the general plan and profile of the dam, as surveyed during the inspection, are presented in Appendix A of this report. Photographs of the facilities taken during the inspection are reproduced in Appendix C.

B. Embankment

The upstream slope of the embankment is in good condition and has a dumped rock surface for protection. The weed growth was moderate and only one small tree was observed on the slope. This tree should be removed. The crest of the dam has a stone surface roadway over most of its length and a small bituminous surfaced area at both sides of the left spillway. The profile on plate A-II indicates that the low point in the crest is at Elevation 1069.1. The horizontal alignment of the dam has a sharp curve near the left end. The embankment butts against the spillway walls at both ends.

The downstream slope has a considerable growth of weeds and heavy brush at several locations (See Plate A-I). Seepage was not detected on the slope, but a wet area was noticed along the toe. Drainage is poor in this area and there is no toe drain. A large flow of water (estimated 40 g.p.m.) was observed at the toe adjacent to a high ridge next to the right spillway. The water was clear and appears to originate from the spillway through the cracked rocks of the spillway. A pond has been constructed about 70 feet beyond the toe. This pond is fed through a siphon from the reservoir and is used to raise bait fish.

C. Appurtenant Structures

This dam has two spillways: one located in the left abutment and one located in the right abutment. The original spillway is the one located in the left abutment. It appears that the embankment and spillway have been changed several times. A stone wall with a concrete face at

the upstream side was placed on the old weir. The height is about seven feet above the apron and the wall is capped with concrete. A vertical slot in this wall is blocked by some boards, and will permit lowering of the reservoir by about 7 feet if the inflow to the reservoir is small.

In 1956 the abutment walls were raised about five feet and piers were erected on the top of this wall to support a vehicle bridge. The upstream right abutment wingwall has tilted and is presumably stabilized with deadman anchors. The downstream left wingwall has large cracks. The overall condition of the walls is poor due to deterioration and cracking.

The representatives of the owners stated that the dam was breached due to overtopping in 1955, caused by failure of an upstream dam (name unknown) and an upstream beaverdam. As a result of that breach, the embankment was raised five feet and an additional spillway was constructed in the right abutment. The ogee section of this spillway appears to be in good condition. However, considerable cracking in the abutment wingwalls has occurred and the upstream left wall is tilted.

D. Reservoir Area

The reservoir area of this dam is wooded with only a few cabins and houses. The banks appear to be stable. Some siltation has been reported in the upper end of the reservoir, but not in recent years.

E. Downstream Channel

The downstream channels of both spillways are wooded and have exposed rock. The banks are stable and the two discharge channels join about 500 feet downstream at Middle Creek. Two-thousand feet downstream of the dam is a summer camp (Camp Watonka) located in a bend of the river. The Borough of Hawley is located about three miles downstream. The hazard category for Wangaum Falls Dam is therefore considered to be "High."

3.2 EVALUATION

The visual inspection of these facilities indicates that the dam is in fair condition. The tilting of walls, the considerable cracking of wingwalls and the deterioration of concrete causes a concern about the stability of these walls. There are no facilities to lower the lake level below spillway elevation in case of an emergency. Some seepage was detected near the toe of the dam. This is partially caused by the lack of a toe drain. The amount of seepage appeared to be small.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The Wangaum Falls Dam is a private recreational reservoir owned by the Wangaum Falls Association. The membership is limited and only about 6 cabins or houses surround the reservoir. The pool level is maintained at spillway elevation and there are no drawdown facilities besides the slot in the left spillway. All inflow above normal pool level is discharged over the spillways. A small (1.5 inch) plastic pipe siphon feeds a small bait pond located at the downstream toe near the left abutment.

4.2 MAINTENANCE OF DAM

Most of the brush cover on the dam is cut once a year, although in several areas, cutting is still required. Several of the abutments and wingwalls of the spillways have tilted. Some of these walls have been stabilized with deadman anchors and the owners' representatives stated that the left upstream wall of the right spillway will be stabilized with a deadman anchor in the near future. Considerable cracking of the abutment walls and wingwalls has occurred and no remedial action has been taken.

4.3 MAINTENANCE OF OPERATING FACILITIES

The operating facilities for the Wangaum Falls Dam consists only of some boards placed in a vertical slot in the left spillway. There are no gates, valves or pipes at these facilities.

4.4 WARNING SYSTEM

There is no formal surveillance and downstream warning system. Only one house is located on the right bank of the reservoir. Most cabins in this area are occupied during the summer months.

4.5 EVALUATION

The overall operational and maintenance procedures for this dam are limited and require additional attention. It is recommended that all brush, trees and high weeds on the embankment be removed, that tilting and cracked walls be reviewed by a professional engineer and repaired. Plans for surveillance of the facilities and a downstream warning system should be developed for use during periods of heavy or prolonged precipitation.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analysis available from PennDER for Wangaum Falls Dam was not very extensive. No area-capacity curve, frequency curve, unit hydrograph, design storm, design flood hydrograph, nor flood routings were available.

B. Experience Data

The maximum known flood at Wangaum Falls Dam occurred on August 18, 1955, when the dam was overtopped and a breach occurred. It was reported that during this event an upstream beaver dam failed, contributing a large amount of impounded water to the flood discharge already flowing in Wangaum Creek. This resulted in the overtopping and breach of Wangaum Falls Dam.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event, until the dam is overtopped. It was noted that the top of the vertically installed stoplogs extended about three feet above the left spillway crest. This would tend to reduce the discharge capacity and creates an additional obstruction on which debris could accumulate. A concern exists about the structural integrity of the spillway walls.

D. Overtopping Potential

Wangaum Falls Dam has a total storage capacity of 784 acre-feet and an overall height of 30 feet above streambed. These dimensions indicate a size classification of "Small". The hazard classification is "High" (See Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is in the range of one-half the Probable Maximum Flood (PMF) to the full PMF. Since this dam has a history of overtopping and failing resulting in loss of life, the SDF should be the full PMF. For this dam, the PMF peak inflow is 13,786 cfs (See Appendix D for HEC-1 inflow computations).

Comparison of the estimated PMF peak inflow of 13,786 cfs with the estimated combined spillway discharge capacity of 8634 cfs indicates that a potential for overtopping of the Wangaum Falls Dam exists.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this dam does not have the necessary storage available to pass the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 70% of a PMF.

E. Spillway Adequacy

The small size category and high hazard category, in accordance with the Corps of Engineers criteria and guidelines, indicates that the spillway design flood for this dam should be in the range of one-half the PMF to the full PMF. Because of this dam's history of failure, the SDF should be the full PMF.

Calculations show that the combined spillway discharge capacity and reservoir storage capacity are capable of handling 70% of the PMF. Although failure of the two upstream dams was not included in the analysis, it should be noted that failure of those two dams would decrease the percent of PMF that Wangaum Falls Dam can pass without overtopping.

Since the combined spillway discharge and reservoir storage capacity cannot pass the PMF but can pass more than one-half of the PMF without overtopping, the combined spillway capacity is judged to be inadequate, but not seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

The visual inspection of Wangaum Falls Dam indicates that the slopes are apparently stable. The surveyed upstream slope was 1.8H to 1V instead of the design slope of 2H to 1V. The slope is well protected with dumped rock and no signs of distress were noticed on the downstream slope. Although leakage was apparent near the downstream area of the right spillway, most of the water appeared to originate from the spillway. Heavy brush on the downstream slope prevents a thorough inspection.

2. Appurtenant Structures

The visual observations of the appurtenant structures indicate that problems exist with the wingwalls of the two spillways. Serious cracking was observed on several of the walls. Other walls are tilting, indicating possible stability problems. One wall has been provided with deadman anchors.

B. Design and Construction Data

1. Embankment

Detailed design and construction data for the embankment are not available. The embankment was repaired and increased in height in 1956. The typical section on Plate III, Appendix E, shows slopes of 2H to 1V and an upstream cutoff trench, 10 feet wide and 4 feet deep. The fill was placed in 6 inch layers and rolled with a 10 ton roller. Heavy riprap was placed on the upstream slope.

2. Appurtenant Structures

The available design data for the spillways are limited to the design drawings reproduced in Appendix E. Plate IV shows the additions to the left spillway. Due to the poor concrete quality, dowels were not used for extension of the walls. New walls were constructed, apparently with new cutoff walls. The right spillway is detailed on Plate V. A typical section of the abutment walls shows a footing width of 5.17 feet for an overall height of 20.5 feet. This width of footing is not adequate for a cantilevered retaining wall of this height and tilting and subsequent failure of the walls can be expected. The reinforcement shown in the typical section is not considered sufficient. Cracking and failure of the wall can be expected if corrective measures are not taken.

C. Operating Records

There are no formal operating records for this dam. Reports indicate that seepage has occurred since reconstruction in 1926. The leakage near the right spillway has been reported since its construction in 1956.

D. Post Construction Changes

Since the last reconstruction was completed in 1956, the only correction made to the structure consisted of the stabilization of a spillway wingwall with deadman anchors.

E. Seismic Stability

This dam is located in Seismic Zone 1 and it is considered that the static stability of the embankment is sufficient to withstand minor earthquake-induced dynamic forces. No studies or calculations have been made to confirm this assumption. The spillway walls are presently in unstable condition and should be improved.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection and the review of available design and construction information indicate that Wangaum Falls Dam and its appurtenant structures are in fair condition. The inspection did not detect any signs of instability of the embankment and its slopes are considered to be adequate. Although seepage is occurring, the amount and location of the seepage does not raise a concern at the present time. Monitoring of this condition is recommended.

The stability of the wingwalls of the spillways is a serious concern. Failure of these walls during a high pool level could cause failure of the dam and endanger the downstream area.

In accordance with the Corps of Engineers evaluation guidelines, the size classification of this dam is small, the hazard classification is high and the recommended SDF is the PMF. The two spillways are inadequate for passing the full PMF peak inflow without overtopping the dam. The combination of storage and spillway capacity is sufficient for passing 70 percent of the PMF and although the spillway is inadequate, it is not considered to be seriously inadequate.

B. Adequacy of Information

Although the available engineering data are not sufficient to make a detailed analysis of the stability of the dam and its appurtenant structures, the available drawings, reports and the observed physical conditions are judged sufficient for making a reasonable assessment of the overall condition of the dam.

C. Urgency

The recommendations presented below should be implemented without delay.

D. Necessity for Additional Studies

Additional studies will be required to ascertain the stability of spillway walls.

7.2 RECOMMENDATIONS

In order to assure the safe operation of this dam, the following recommendations are presented for implementation by the owner:

1. That a professional engineer, experienced in the design and construction of dams, reviews the stability of the spillway walls. His recommendations for improvement should be implemented immediately.

2. That the seepage in the downstream area be monitored on a regular basis. If a volume of flow increase is detected or if a discoloration is noticed, immediate steps shall be taken to correct this condition.

3. That all brush and weed growth be removed from the embankment and in an area 20 feet beyond the downstream toe and that this be repeated on a regular basis.

4. That a formal surveillance and downstream warning system be developed for implementation during periods of heavy or prolonged rainfall.

5. That a program be developed for regular inspection and maintenance of the dam and its appurtenant structures.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 64-102 NDI NO. PA-00 141

NAME OF DAM WANGAUM FALLS DAM HAZARD CATEGORY High

TYPE OF DAM Earthfill

LOCATION Paupack TOWNSHIP Wayne COUNTY, PENNSYLVANIA

INSPECTION DATE 10/25/79 WEATHER Cloudy, Cold TEMPERATURE 40's

INSPECTORS: R.V. Houseal (Recorder) OWNER'S REPRESENTATIVE(s):

H. Jongsma Edwin Thomas

R. Shireman Robert W. Birdsall

A.W. Bartlett

NORMAL POOL ELEVATION: 1057 U.S.G.S. AT TIME OF INSPECTION:

BREAST ELEVATION: 1069.1 POOL ELEVATION: 1057

SPILLWAY ELEVATION: 1057 & 1056.8 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: Unknown

GENERAL COMMENTS:

Earth Embankment - Two spillways - Left Side: broad crested weir with stoplogs (10" each) - in vertical slot. Bridge on support - 5 piers; Right Side: uncontrolled ogee section - roadway across top of embankment - bridge across each spillway.

NDI NO. PA-00 141

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None observed.
B. UNUSUAL MOVEMENT BEYOND TOE	None detectible.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None observed.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Horizontal alignment - curve & tangent okay. Verticle - see profile Plate A-II.
E. RIPRAP FAILURES	Upstream slope of embankment covered with dumped rock with some short weed growth. One small evergreen tree. Rip rap is in stable condition.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Embankment abuts one spillway wall at both the left and right ends. The abutments appear to be stable.
G. SEEPAGE	Refer to sketch Plate A-I.
H. DRAINS	One small diameter plastic pipe is carried over the dam to the small pond downstream at the left end of the embankment. This siphon is the water supply for the small pond. The pond is
J. GAGES & RECORDER	used to raise bait fish. None.
K. COVER (GROWTH)	Top - Stone surface roadway. Upstream - dumped rock with moderate weed growth and one small evergreen tree. Downstream - weed growth & brush.

NDI NO. PA-00 141

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	None.
B. OUTLET STRUCTURE	None.
C. OUTLET CHANNEL	None.
D. GATES	None.
E. EMERGENCY GATE	Stoplogs in vertical slot could lower lake about 7 feet.
F. OPERATION & CONTROL	None.
G. BRIDGE (ACCESS)	None.

NDI NO. PA-00 141

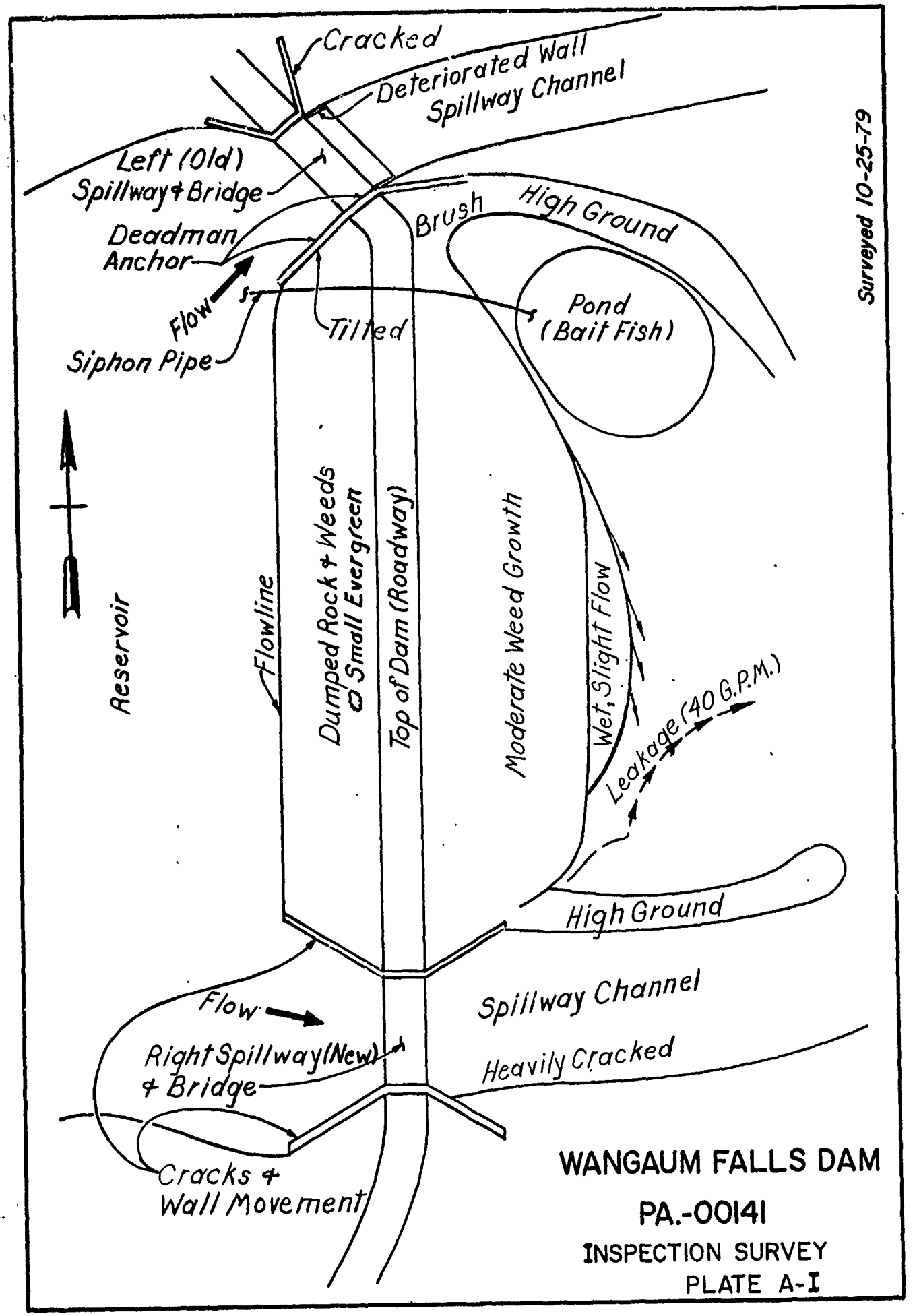
VISUAL INSPECTION
SPILLWAY

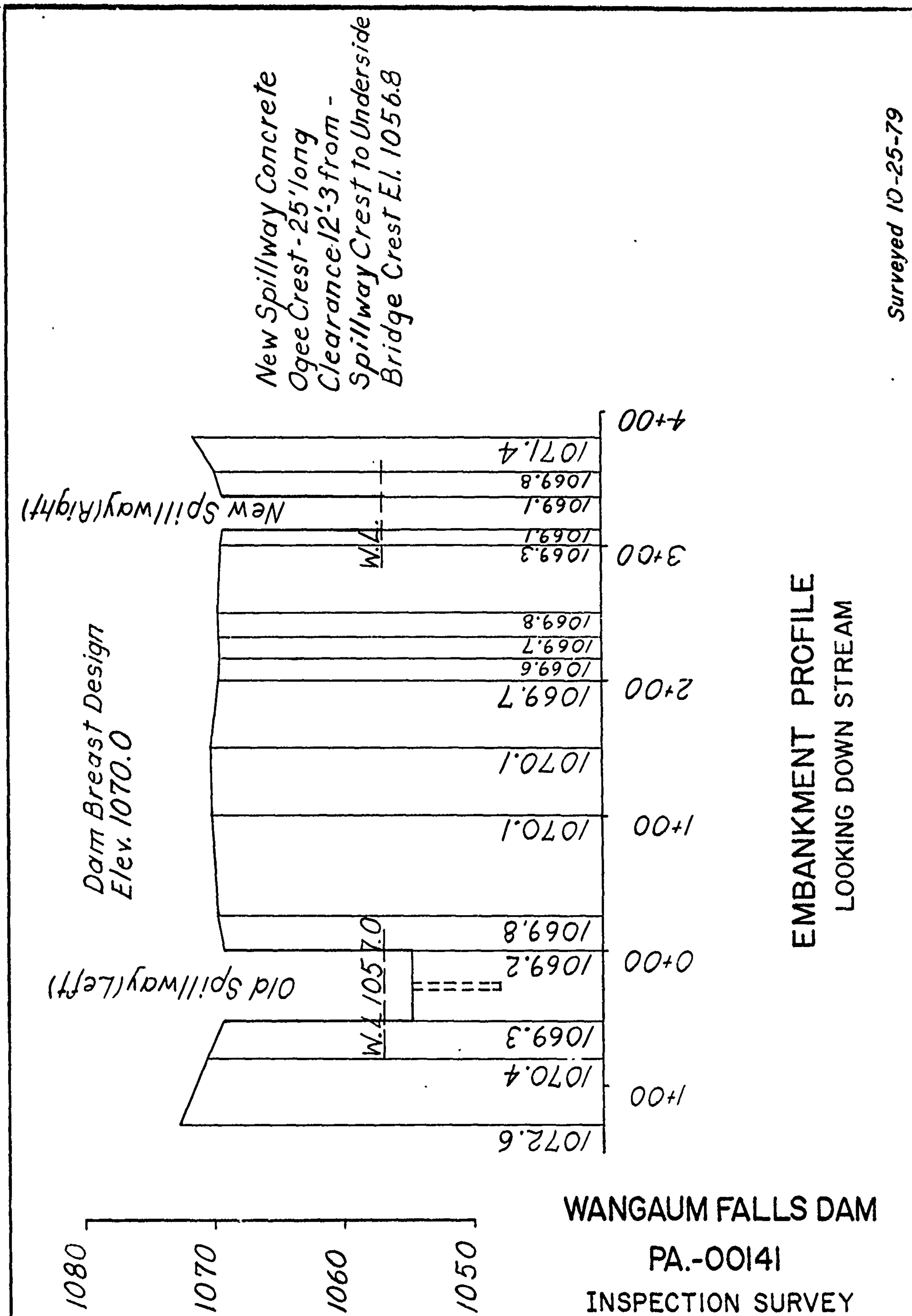
	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Left Spillway - directly from reservoir left side. Right Spillway - directly from reservoir right side.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Left - Broad crested weir (5 piers for bridge) Right - Ogee section, unobstructed. Left Walls - some cracks & deterioration. Right Walls - major diagonal cracks thru walls and some surface spalling.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	Left - natural stream rock bottom steep sides - paved apron - no basin. Right - natural stream rock bottom steep sides - no basin - concrete apron.
D. BRIDGE & PIERS	Left - wooden deck, steel beams, 5 piers. Right - wooden deck, steel beams, no piers.
E. GATES & OPERATION EQUIPMENT	Left - Stoplogs - 4 @ 10" each in a 7 feet deep slot. Right - Uncontrolled.
F. CONTROL & HISTORY	Dam was breached in 1955, partially caused by failure of a beaver dam and another dam upstream. Dam was raised 5 feet and the second spillway was installed.

NDI NO. PA-00 141

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
RESERVOIR	
Slopes	Wooded - stable - Est. 2:1.
Sedimentation	None reported except some at the upstream end of the reservoir.
Watershed Description	Mostly wooded.
DOWNSTREAM CHANNEL	
Condition	Natural stream with heavy rocks.
Slopes	Stable, rock surface, treelined.
Approximate Population	Summer Camp, Camp Watonka, population varies.
No. Homes	Several cabins.


Cracked
Deteriorated Wall
Spillway Channel
Left (Old)
Spillway & Bridge
Deadman
Anchor
Brush
High Ground
Flow
Tilted
Pond
(Bait Fish)
Siphon Pipe
Surveyed 10-25-79
Reservoir
Flowline
Dumped Rock & Weeds
& Small Evergreen
Top of Dam (Roadway)
Moderate Weed Growth
Wet, Slight Flow
Leakage (40 G.P.M.)
High Ground
Spillway Channel
Flow
Right Spillway (New)
& Bridge
Heavily Cracked
Cracks &
Wall Movement
WANGAUM FALLS DAM
PA.-00141
INSPECTION SURVEY
PLATE A-I

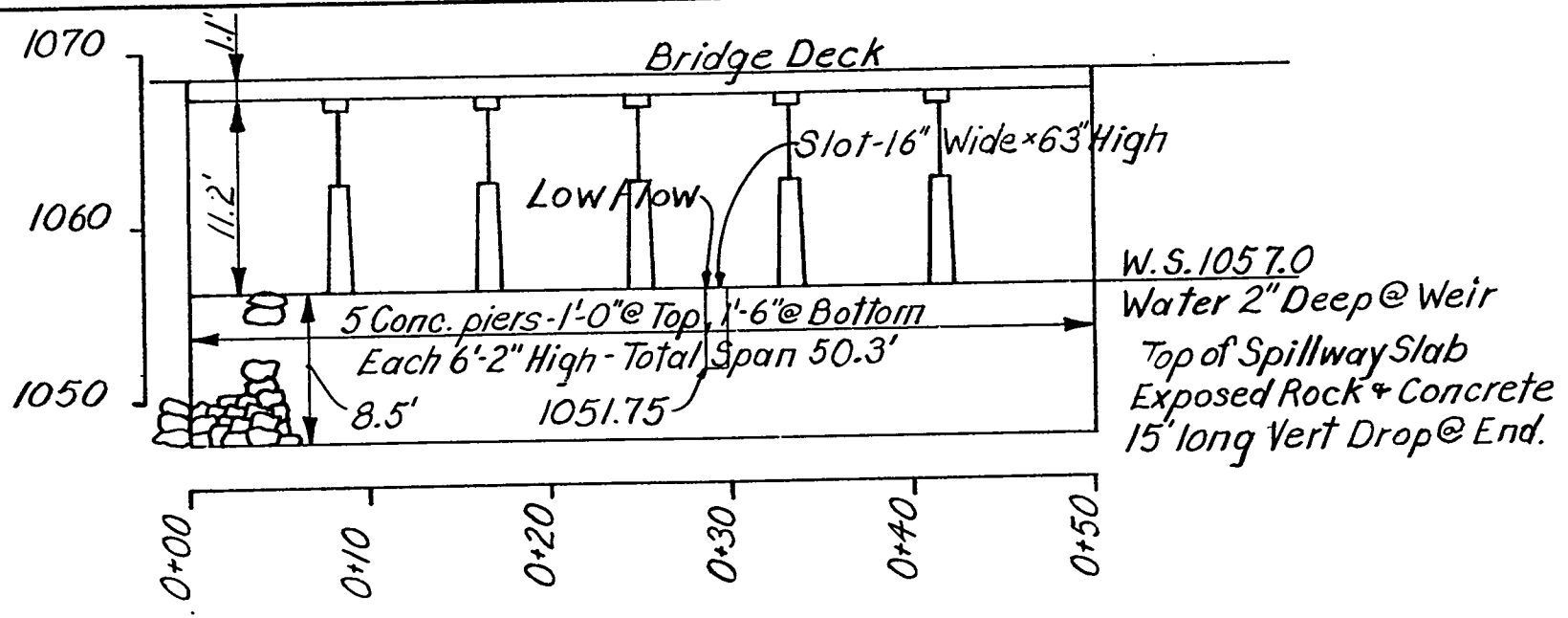


WANGAUM FALLS DAM

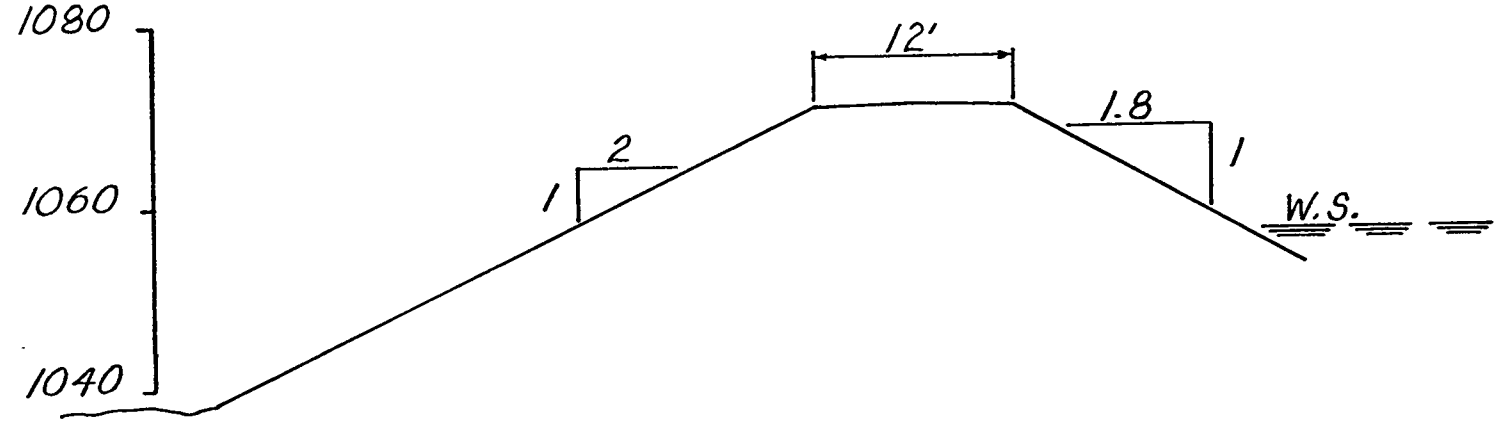
PA.-00141

INSPECTION SURVEY

PLATE A-II



ELEVATION - OLD SPILLWAY LEFT ABUTMENT



EMBANKMENT SECTION

Surveyed 10-25-79

WANGAUM FALLS DAM

PA.-00141

INSPECTION SURVEY

PLATE A-III

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 64-102 NDI NO. PA-00 141

NAME OF DAM WANGAUM FALLS DAM

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle Hawley, Pa. See Plate II, Appendix E
CONSTRUCTION HISTORY	Old mill pond, which was breached. Rebuilt in 1926 with a spillway in breach. Dam breached in 1955, repaired in 1956. Dam raised 5 feet and new spillway added in right abutment. Information from PennDER files.
GENERAL PLAN OF DAM	See Appendix E, Plate III.
TYPICAL SECTIONS OF DAM	See Appendix E, Plate IV & Appendix A.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	Appendix E. Some calculations by PennDER for permit approval. PennDER files.

NDI NO. PA-00141

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	No records.
DESIGN REPORTS	None located.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None, except some calculations by PennDER to check spillway capacities in 1956. None. None.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	None.
POST CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	Unknown.

NDI NO. PA-00 141

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Dam raised in 1956 by 5 feet, and spillway added. See Plates in Appendix E.
HIGH POOL RECORDS	Not existing.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	After reconstruction in 1926, dam was breached in 1955 due to overtopping. Owner stated that this was caused by failure of an upstream beaver dam. There are no engineering records. Letters indicate possibility of a low point in embankment.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	See Appendix E. These are the only available drawings.

NDI NO. PA-00 141

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	None.
CONSTRUCTION RECORDS	Two letters from the Design Engineer dated December 1956. These letters detail some of the
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	Inspection reports by PennDER indicating seepage at toe, heavy brush on downstream slope.
MISCELLANEOUS	

NDI NO. PA-00 141

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Mostly wooded.

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 1057 Acre-Feet 168.8

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev. 1069.1 Acre-Feet 784

MAXIMUM DESIGN POOL: Elev. 1069.1

TOP DAM: Elev. 1069.1

SPILLWAY:	LEFT	RIGHT
a. Elevation	1057	1056.8
b. Type	broad crested	ogee
c. Width	50.3 ft.	25 ft.
d. Length	6 ft.	--
e. Location Spillover	left abutment	right abutment
f. Number and Type of Gates	none	none

OUTLET WORKS:

a. Type Stoplog opening

b. Location Near center of left spillway

c. Entrance inverts 1050.4

d. Exit inverts 1050.4

e. Emergency drawdown facilities Stoplog opening

HYDROMETEOROLOGICAL GAGES:

a. Type None

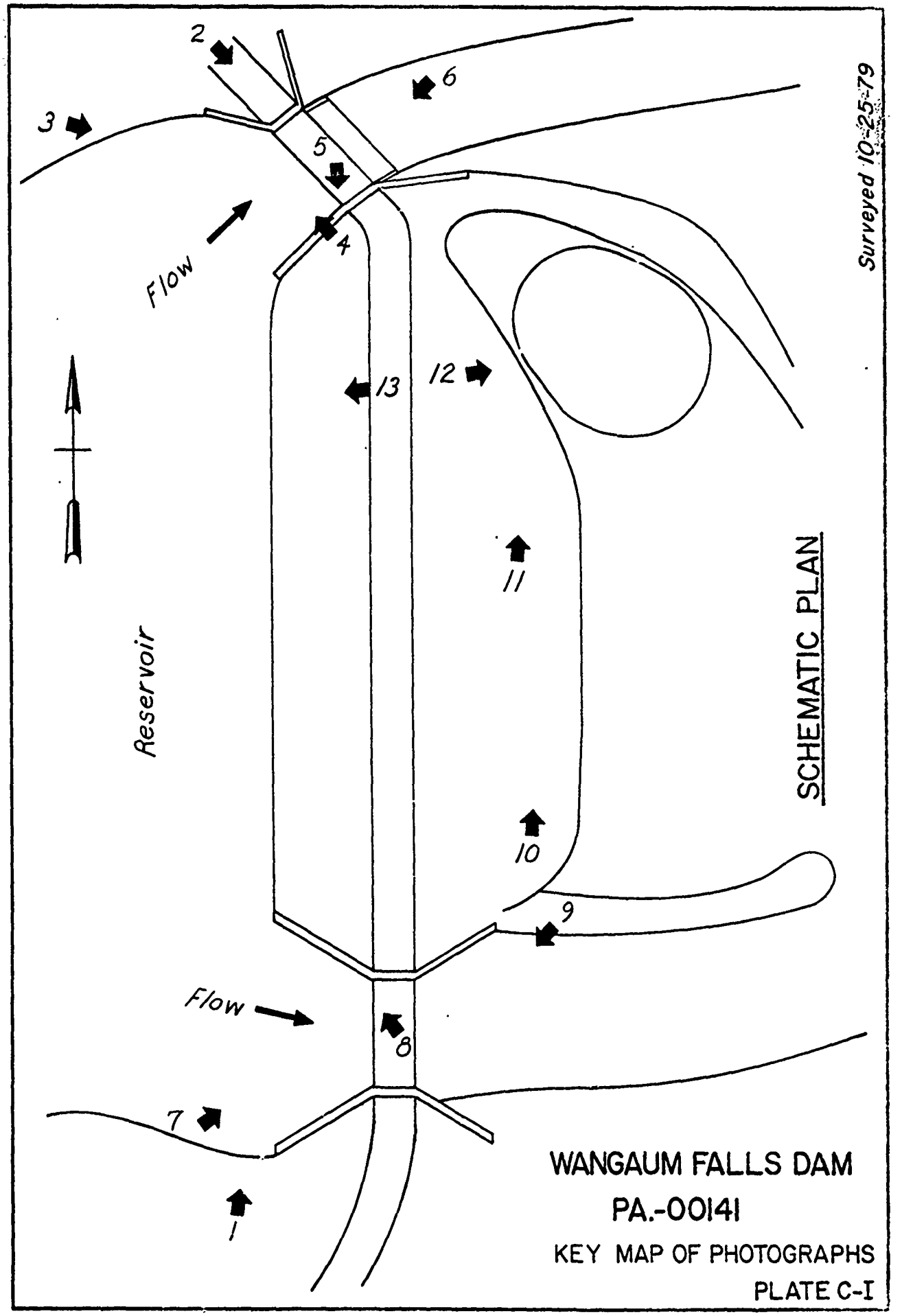
b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 8634 cfs

APPENDIX C

PHOTOGRAPHS

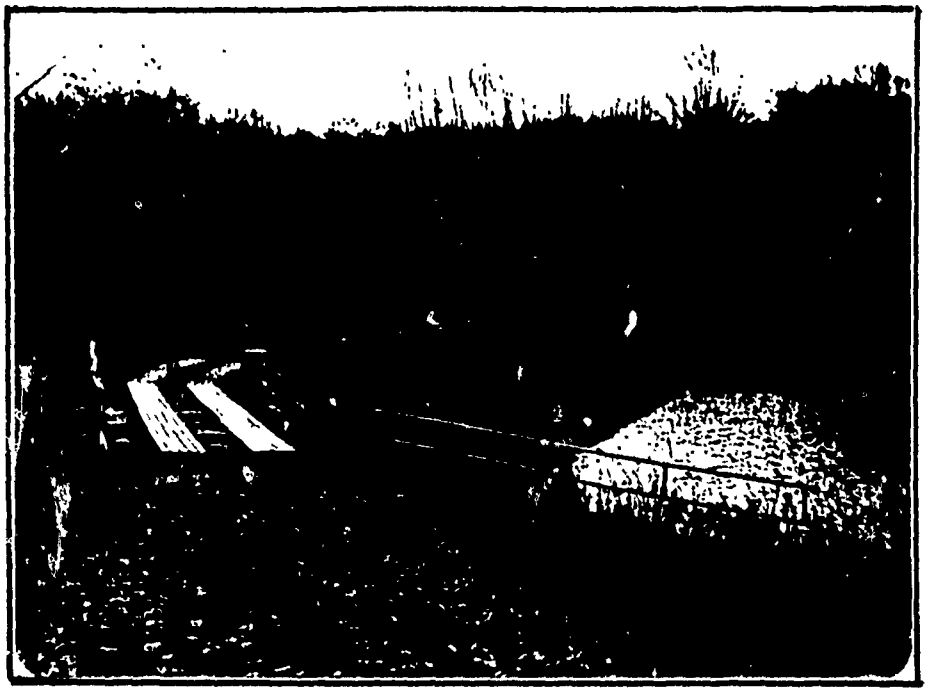


WANGAUM FALLS DAM

PA.-00141

KEY MAP OF PHOTOGRAPHS

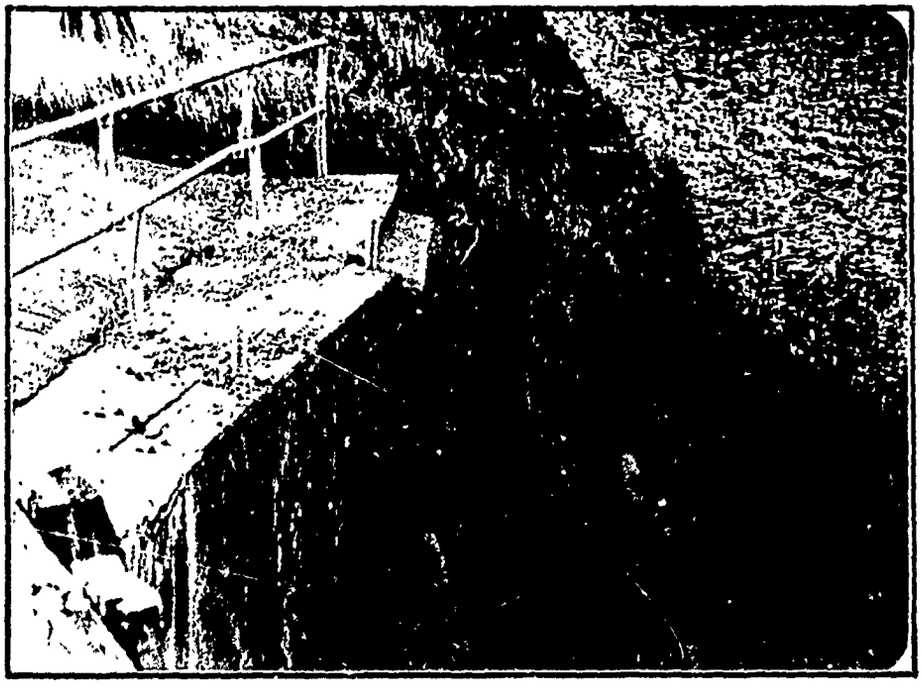
PLATE C-I



BRIDGE OVER LEFT SPILLWAY - NO. 2

UPSTREAM VIEW, LEFT SPILLWAY - NO. 3

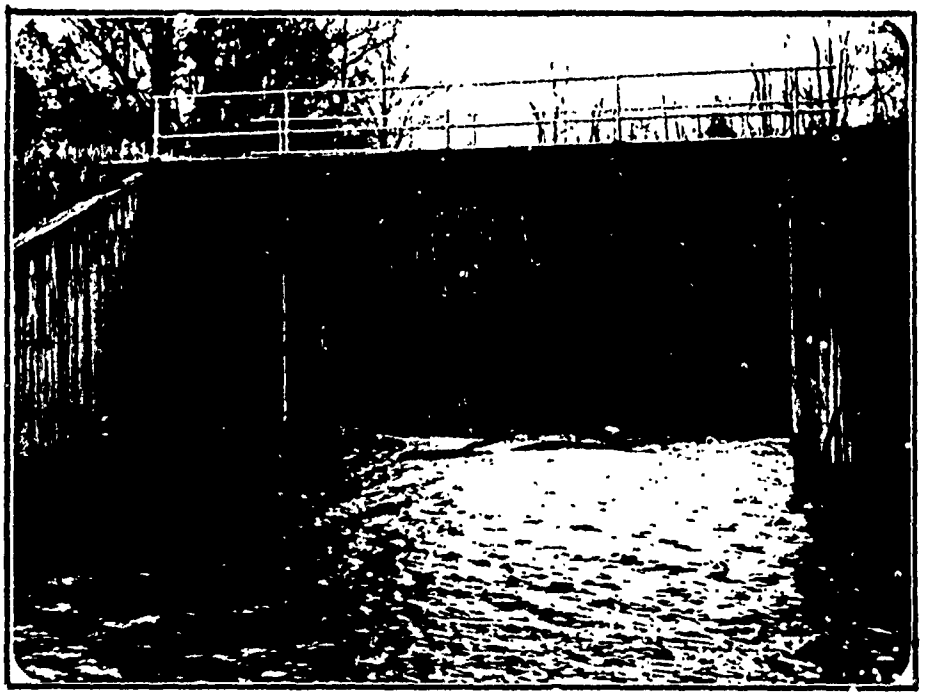
CRACKED LEFT WINGWALL, LEFT SPILLWAY - NO. 4



TILTING AND ANCHORED RIGHT WINGWALL
LEFT SPILLWAY - NO. 5

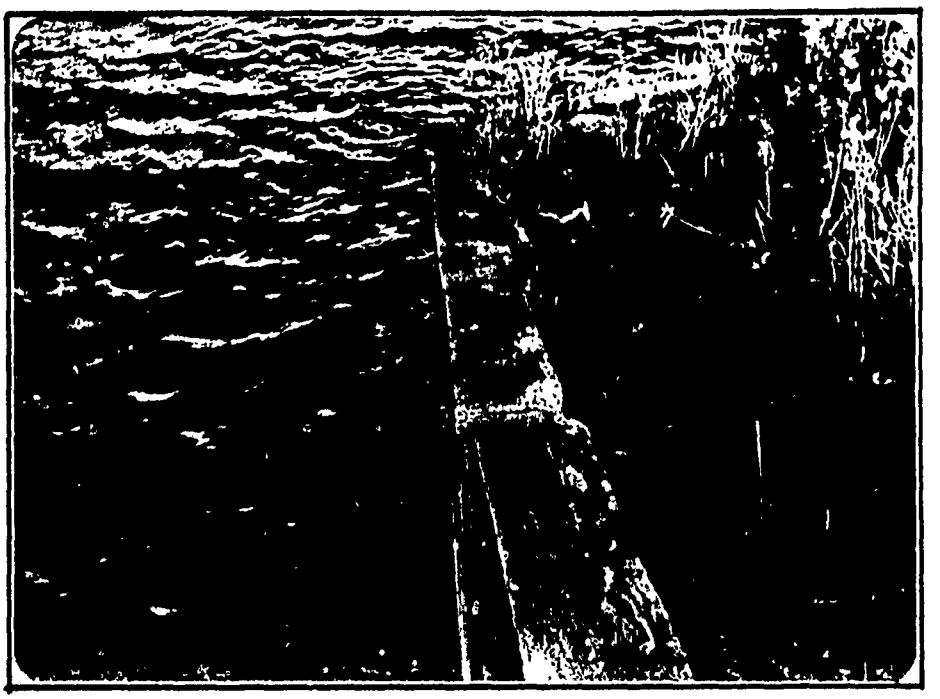
PA-00141
Plate C-III

DOWNSTREAM SIDE, LEFT SPILLWAY - NO. 6

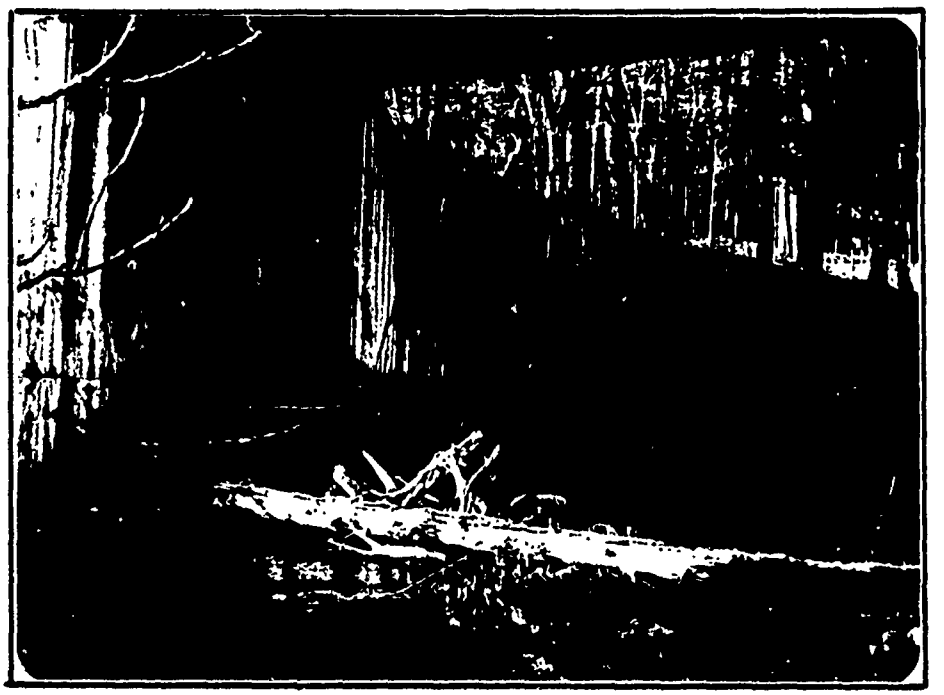


UPSTREAM SIDE, RIGHT SPILLWAY - NO. 7

PA-00141
Plate C-IV



TILTING LEFT WINGWALL, RIGHT SPILLWAY - NO. 8



OGEE SECTION, RIGHT SPILLWAY - NO. 9

PA-00141
Plate C-V

DOWNSTREAM SLOPE WITH BRUSH
TREES CLOSE TO TOE - NO. 10

DOWNSTREAM SLOPE LEFT SIDE - NO. 11

PA-00141
Plate C-VI

POND DOWNSTREAM OF DAM - NO. 12

RESERVOIR AREA - NO. 13

PA-00141
Plate C-VII

APPENDIX D

HYDKOLOGY AND HYDRAULIC CALCULATIONS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

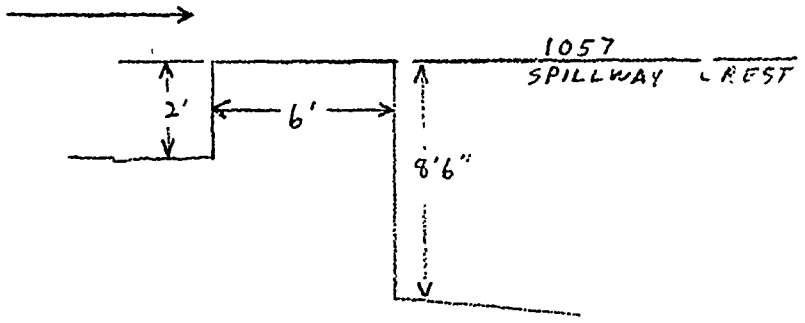
The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

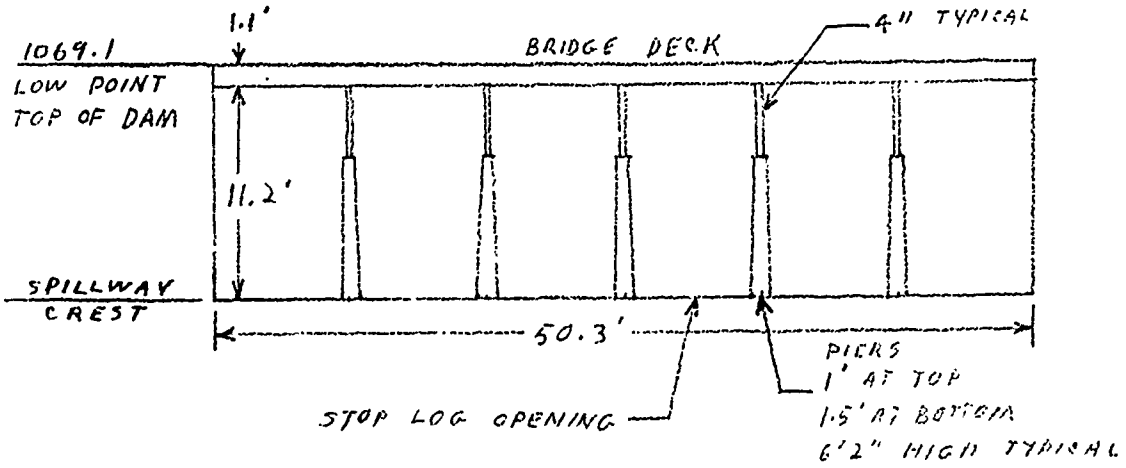
For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

BY RLS DATE 1/11/80 **BERGER ASSOCIATES** SHEET NO. 1 OF
CHKD. BY DATE PROJECT D9650
SUBJECT WANGAUM FALLS DAM

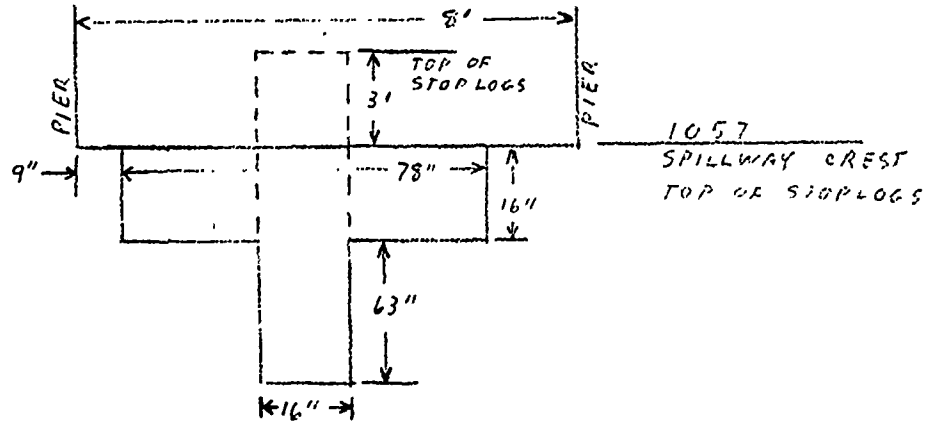
SPILLWAY RATING - LEFT SIDE



BROAD CRESTED WEIR
C = 3.1 (ESTIMATED FROM KING'S HDBK.)



STOP LOG OPENING



BY RLS DATE 1/14/80 **BERGER ASSOCIATES** SHEET NO. 2 OF
CHKD. BY DATE PROJECT 09650
SUBJECT WANGAUM FALLS DAM

SPILLWAY - LEFT SIDE

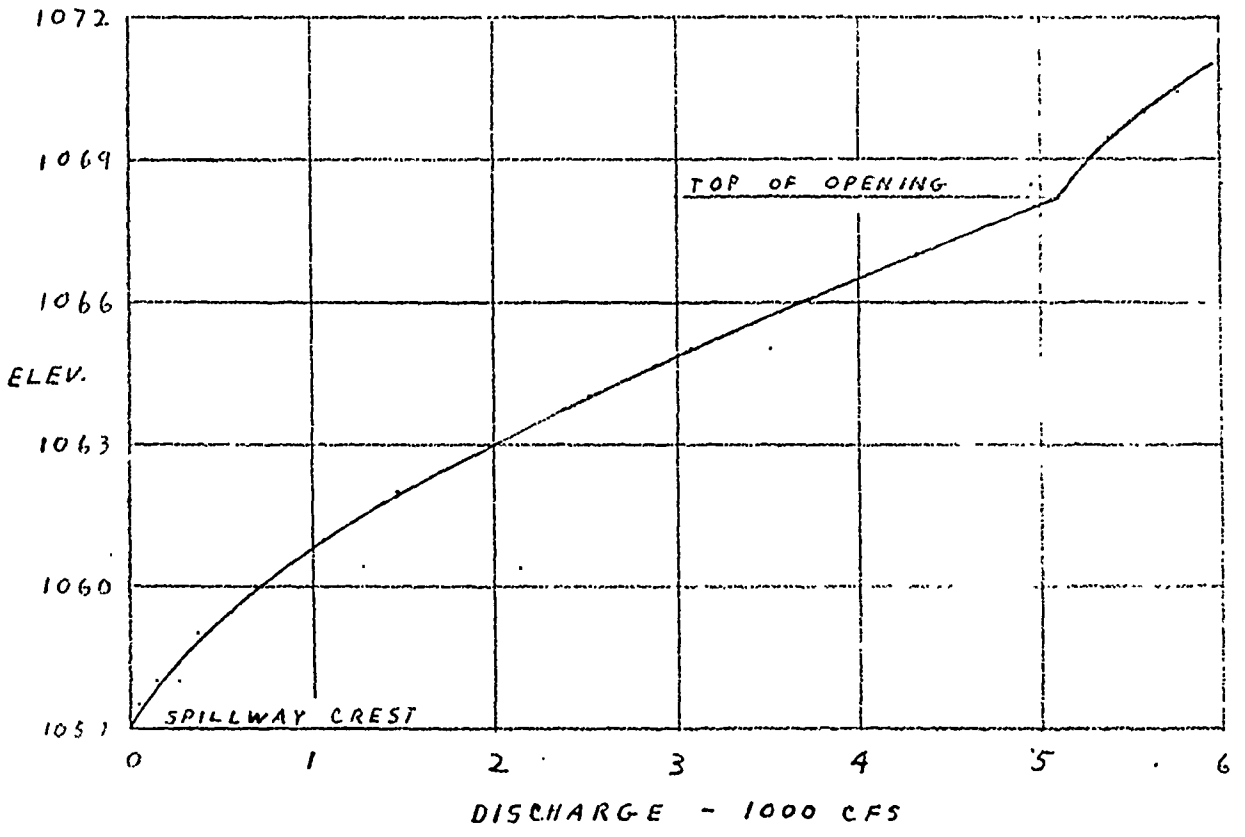
DISCHARGE CAPACITY

AT POOL ELEV. 1068.2, TOP OF OPENING

$$Q = C\,L\,H^{3/2}$$

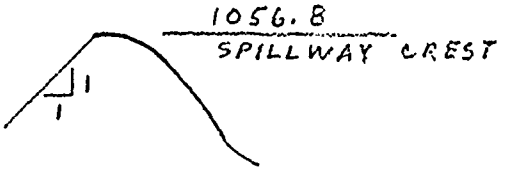
$$= 3.1 \times \left(50.3 - \left(5 \times \frac{1+1.5}{2}\right)\right) \times (11.2)^{1.5} = 5118 \text{ CFS}$$

DISCHARGE CURVE



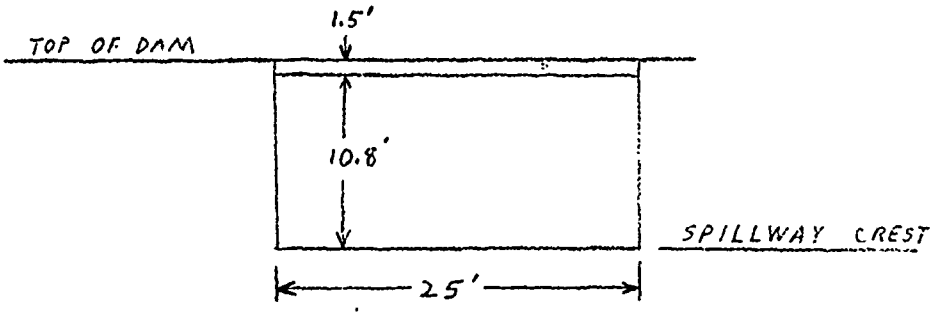
BY RLS DATE 1/15/80 **BERGER ASSOCIATES** SHEET NO. 3 OF
CHKD. BY ____ DATE ____ PROJECT D9650
SUBJECT WANGAUM FALLS DAM

SPILLWAY RATING - RIGHT SIDE



OGEE SECTION
WITH SLOPING FACE

$C = 3.88 \times 1.01 = 3.92$ (SMALL DAMS FIG. 249 + 251)



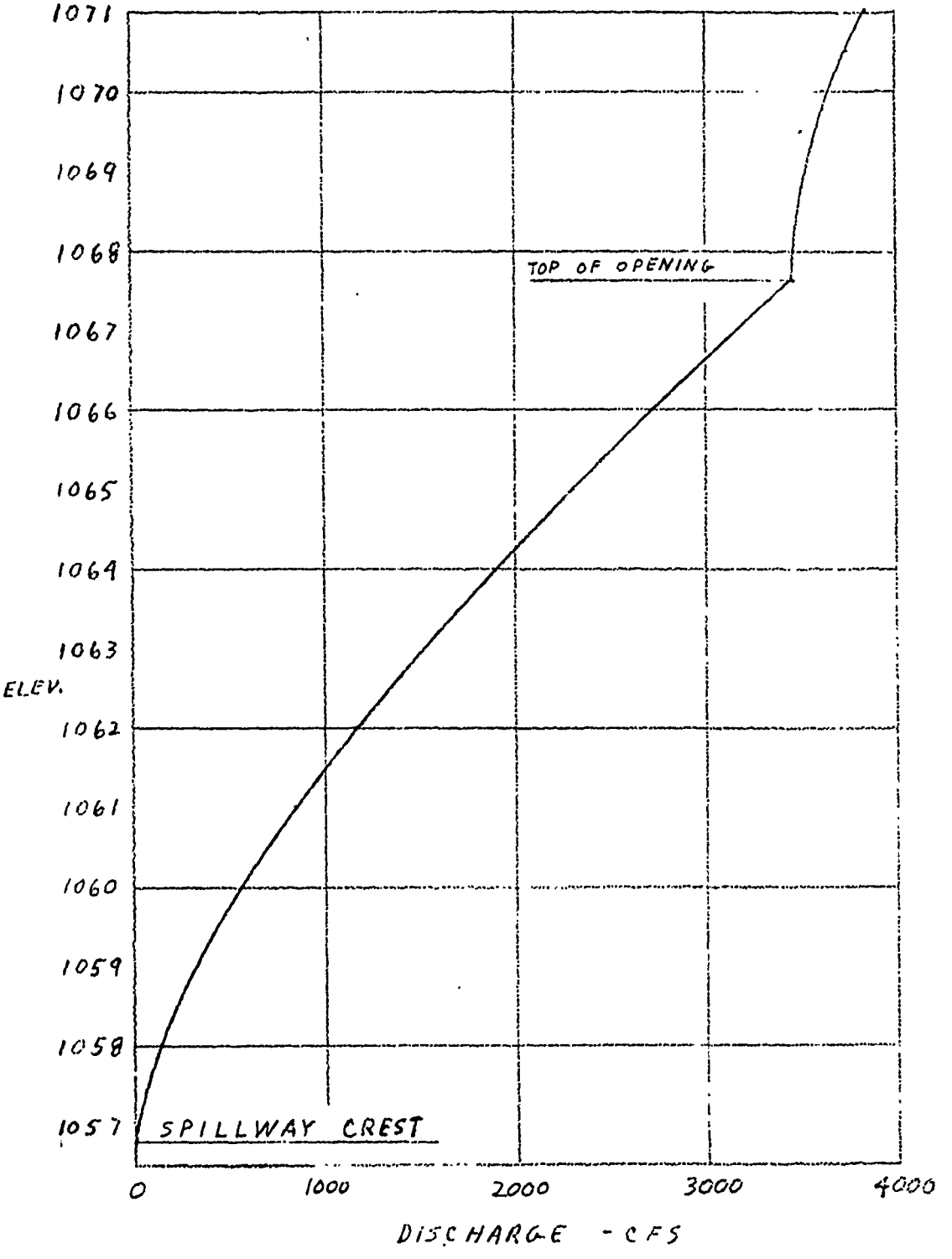
AT POOL ELEV. 1067.6, TOP OF OPENING

$Q = C L H^{3/2}$

$= 3.92 \times 25 \times (10.8)^{1.5} = 3478$ CFS

BY RLS DATE 1/15/80 **BERGER ASSOCIATES** SHEET NO. 4 OF
CHKD. BY DATE PROJECT D965C
SUBJECT WANGAUM FALLS DAM

SPILLWAY DISCHARGE CURVE - RIGHT SIDE



BY RLS DATE 1/23/80 **BERGER ASSOCIATES** SHEET NO. 5 OF
CHKD. BY DATE PROJECT D9650
SUBJECT WANGANUM FALLS DAM

EMBANKMENT RATING

$Q = C L H^{3/2}$ $C = 2.7$ (KING'S HDBK)

AT ELEV. 1069.5

$2.7 \times 8 \times (.2)^{1.5} = 2$
$2.7 \times 10 \times (.3)^{1.5} = 4$
$2.7 \times 20 \times (.1)^{1.5} = 2$
$2.7 \times 12 \times (.1)^{1.5} = 2$
$2.7 \times 5 \times (.1)^{1.5} = -$ $\Sigma = 10$

AT ELEV 1070

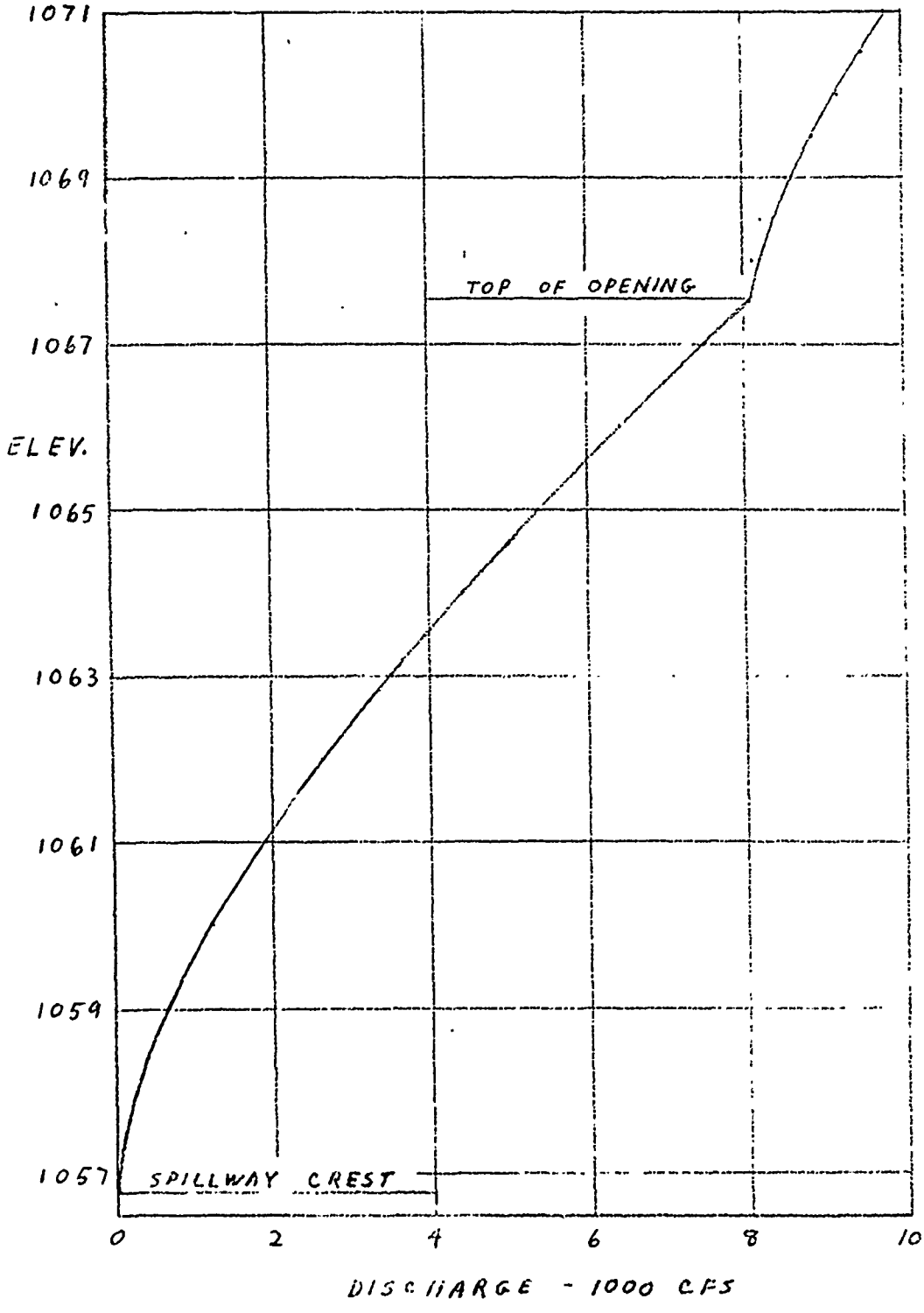
$2.7 \times 14 \times (.55)^{1.5} = 15$
$2.7 \times 3 \times (.1)^{1.5} = -$
$2.7 \times 10 \times (.8)^{1.5} = 19$
$2.7 \times 50 \times (.45)^{1.5} = 41$
$2.7 \times 20 \times (.25)^{1.5} = 7$
$2.7 \times 30 \times (.35)^{1.5} = 17$
$2.7 \times 37 \times (.15)^{1.5} = 6$
$2.7 \times 50 \times (.1)^{1.5} = 4$
$2.7 \times 16 \times (.35)^{1.5} = 9$ $\Sigma = 142$
$2.7 \times 25 \times (.5)^{1.5} = 24$

AT ELEV 1071

$2.7 \times 14 \times (1.55)^{1.5} = 73$
$2.7 \times 19 \times (.6)^{1.5} = 24$
$2.7 \times 10 \times (1.8)^{1.5} = 65$
$2.7 \times 50 \times (1.45)^{1.5} = 236$
$2.7 \times 20 \times (1.25)^{1.5} = 75$
$2.7 \times 30 \times (1.35)^{1.5} = 127$
$2.7 \times 50 \times (1.1)^{1.5} = 156$
$2.7 \times 50 \times (.9)^{1.5} = 115$
$2.7 \times 75 \times (1.05)^{1.5} = 218$
$2.7 \times 25 \times (1.5)^{1.5} = 124$
$2.7 \times 25 \times (1.15)^{1.5} = 83$
$2.7 \times 13 \times (.3)^{1.5} = 6$ $\Sigma = 1302$

BY RLS DATE 1/16/80 **BERGER ASSOCIATES** SHEET NO. 6 OF
CHKD. BY DATE PROJECT D9650
SUBJECT WANGAUM FALLS DAM

TOTAL DISCHARGE CURVE



MAXIMUM KNOWN FLOOD AT DAM SITE

THE MAXIMUM KNOWN FLOOD AT WANGAUM FALLS DAM OCCURRED ON AUGUST 18, 1955 WHEN THE DAM WAS OVERTOPPED AND A BREACH OCCURRED. DURING THIS EVENT AN UPSTREAM BEAVER DAM FAILED, CONTRIBUTING A LARGE AMOUNT OF IMPOUNDED WATER TO THE FLOOD DISCHARGE ALREADY FLOWING. THIS RESULTED IN THE OVERTOPPING AND BREACH OF WANGAUM FALLS DAM.

BASED ON RECORDS OF THE MIDDLE CREEK GAGE, LOCATED ABOUT 2 MILES DOWNSTREAM OF THE CONFLUENCE OF WANGAUM CREEK WITH MIDDLE CREEK (D.A. = 78.4 SQ. MI.) THAT STORM PRODUCED A PEAK DISCHARGE OF 12,000 CFS.

THE MAXIMUM INFLOW TO WANGAUM FALLS DAM IS ESTIMATED TO BE:

$$\left(\frac{8.39}{78.4}\right)^{0.9} \times 12000 = 2008 \text{ CFS}$$

BY RLS DATE 1/16/80 BERGER ASSOCIATES SHEET NO. 8 OF
CHKD. BY DATE PROJECT D.9650
SUBJECT WANGAUM FALLS DAM

SIZE CLASSIFICATION

MAXIMUM STORAGE = 784 ACRE-FEET
MAXIMUM HEIGHT = 30 FEET
SIZE CLASSIFICATION IS SMALL

HAZARD CLASSIFICATION

A CAMPGROUND AND THE TOWN OF HAWLEY ARE LOCATED ALONG THE DOWN STREAM CHANNEL.

USE "HIGH"

RECOMMENDED SPILLWAY DESIGN FLOOD

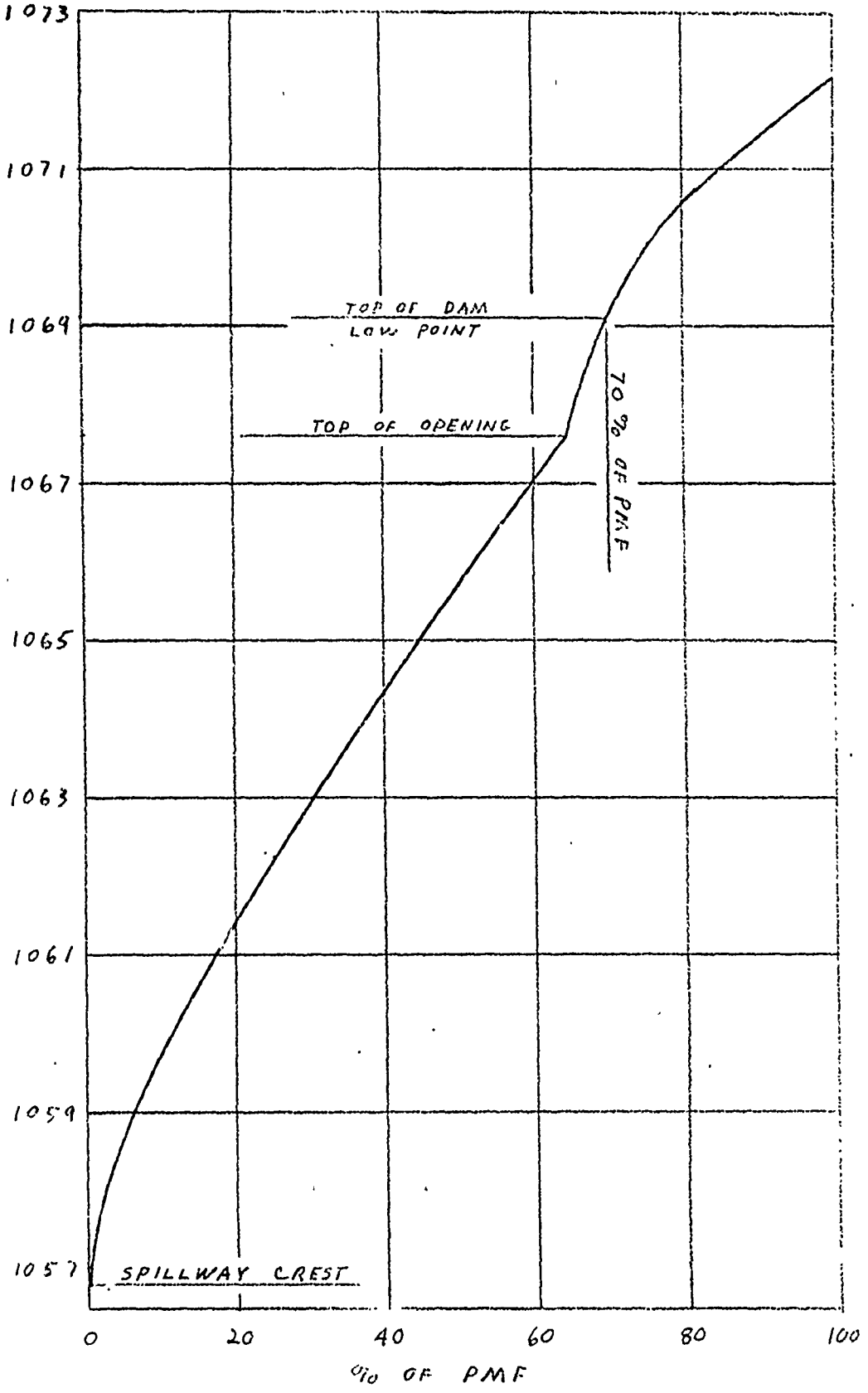
THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO ONE HALF PMF TO THE FULL PROBABLE MAXIMUM FLOOD.

BY RLS DATE 3/5/80 **BERGER ASSOCIATES** SHEET NO. 9 OF.

CHKD. BY DATE PROJECT D9650

SUBJECT WANGAUM FALLS DAM

SPILLWAY CAPACITY CURVE



HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: WANGAUM FALLS RIVER BASIN: DELAWARE

PROBABLE MAXIMUM PRECIPITATION (PMP) = 21.5 INCHES/24 HOURS[1]

(FOR FOOTNOTES SEE NEXT PAGE)

STATION		1	2	3	4
STATION DESCRIPTION		CLEMO POND	CLEMO POND DAM	COBB LAKE	COBB LAKE DAM
DRAINAGE AREA (SQUARE MILES)		.41		.72	
CUMULATIVE DRAINAGE AREA (SQUARE MILE)		.41	.41	.72	.72
ADJUSTMENT OF PMP FOR DRAINAGE AREA (%)[2]	6 HOURS	111		111	
	12 HOURS	123		123	
	24 HOURS	133		133	
	48 HOURS	142		142	
	72 HOURS				
SNYDER HYDROGRAPH PARAMETERS	ZONE[3]	1		1	
	C_p / C_t[4]	0.45/1.23		0.45/1.23	
	L (MILES)[5]	L' = .33		1.46	
	L_{ca} (MILES)[5]			.63	
	$T_p = C_t (L \cdot L_{ca})^{0.3}$ (hours)	$T_p = C_t (L')^{.6}$ = .63		1.20	
SPILLWAY DATA	CREST LENGTH (FT.)		8		20
	FREEBOARD (FT.)		1		2
	DISCHARGE COEFFICIENT		2.7		2.7
	EXPONENT		1.5		1.5
	ELEVATION		1411		1327
AREA[6] (ACRES)	NORMAL POOL		83.3		37.2
	ELEV. _____	1420 =	116.3	1340 =	57.4
	ELEV. _____				
STORAGE (ACRE-FEET)	NORMAL POOL[7]		27.6		306.9
	ELEV. _____[8]	1410 =	0	1302.3 =	0
	ELEV. _____[8]				
	ELEV _____[8]				

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: WANGAUM FALLS RIVER BASIN: DELAWARE

PROBABLE MAXIMUM PRECIPITATION (PMP) = _____ INCHES/24 HOURS (1)

(FOR FOOTNOTES SEE NEXT PAGE)

STATION		1	2	3	4
STATION DESCRIPTION		WANGAUM FALLS LAKE	WANGAUM FALLS DAM		
DRAINAGE AREA (SQUARE MILES)		7.26			
CUMULATIVE DRAINAGE AREA (SQUARE MILE)		8.39	8.39		
ADJUSTMENT OF PMP FOR DRAINAGE AREA (%) (2)	6 HOURS	111			
	12 HOURS	123			
	24 HOURS	133			
	48 HOURS	142			
	72 HOURS				
SNYDER HYDROGRAPH PARAMETERS	ZONE (3)	1			
	C_p / C_t (4)	0.45/1.23			
	L (MILES) (5)	4.91			
	L_{ca} (MILES) (5)	3.13			
	$T_p = C_t (L \cdot L_{ca})^{0.3}$ (hours)	2.79			
SPILLWAY DATA			LEFT / RIGHT		
	CREST LENGTH (FT.)		50.3 / 25		
	FREEBOARD (FT.)		12.1 / 12.3		
	DISCHARGE COEFFICIENT		3.1 / 3.92		
	EXPONENT		1.5 / 1.5		
	ELEVATION		1057 / 1056.8		
AREA (6) (ACRES)	NORMAL POOL		32.8		
	ELEV. 1060		43.8		
	ELEV. 1080		101.9		
STORAGE (ACRE-FEET)	NORMAL POOL (7)		168.8		
	ELEV. 1041.6 XX		0		
	ELEV. _____ (8)				
	ELEV _____ (9)				

(1) Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

(2) Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

(3) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

(4) Snyder's Coefficients.

(5) L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

(6) Planimetered area encompased by contour upstream of dam.

(7) PennDER files.

(8) Computed by conic method.

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
*********************************
    1          A1      WANGAUM FALLS DAM    ***    WANGAUM CREEK
    2          A2      PAUPACK TWP., WAYNE COUNTY, PA.
    3          A3      NDI # PA-00141     PA DER # 64-102
    4          B   300      0     15      0      0      0      0      0     -4      0
    5          B1    5
    6          J     1      9      1
    7          J1    1     .9     .8     .7     .6     .5     .4    .25     .1
    8          K             1                                    1
    9          K1              INFLOW  HYDROGRAPH - LAKE CLEMO SUBAREA
   10          M     1       1    .41           8.39
   11          P           21.5    111    123    133    142
   12          T                                                 1    .05
   13          W   .63    .45
   14          X  -1.5    .05      2
   15          K     1       2                                   1
   16          K1              RESERVOIR  ROUTING - THRU LAKE CLEMO
   17          Y                              1
   18          Y1    1                                    27.6
   19          $A    0   83.3   116.3
   20          $E 1410   1411   1420
   21          $$ 1411      8    2.7    1.5
   22          $D 1412    2.7    1.5    150
   23          K     1       3                                   1
   24          K1              ROUTING THRU REACH 2 - 3
   25          Y                              1
   26          Y1    1
   27          Y6   .1    .05     .1   1369   1420   1650   .022
   28          Y7    0   1420    450   1400    630   1380    700   1369    760   1369
   29          Y7  800   1380   1170   1400   1430   1420
   30          K     1       4                                   1
   31          K1              ROUTING THRU REACH 3 - 4
   32          Y                              1
   33          Y1    1
   34          Y   .1    .07     .1   1275   1320   3900   .045
   35          Y7    0   1320    280   1300    320   1280    340   1275    350   1275
   36          Y7  380   1280    550   1300    680   1320
   37          K             5                                   1
   38          K1              INFLOW HYDROGRAPH - COBB POND SUBAREA
   39          M     1       1    .72           8.39
   40          P           21.5    111    123    133    142
   41          T                                                 1    .05
   42          W   1.2    .45
   43          X  -1.5   -.05      2
   44          K     1       6                                   1
   45          K1              RESERVOIR ROUTING - THRU COBB POND
   46          Y                              1
   47          Y1    1                                   306.9
   48          $A    0   37.2   57.4
   49          $E1302.3   1327   1340
   50          $$ 1327      20    2.7    1.5
1  51          $D 1329    2.7    1.5    300
   52          K     1       7                                   1
   53          K1              ROUTING THRU REACH 6 - 7
   54          Y                              1
   55          Y1    1
   56          Y6   .1    .08     .1   1283   1340   2350   .0125
   57          Y7    0   1340    350   1320    440   1300    730   1283    740   1283
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2/25

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K     1      7                                         1
K1               ROUTING THRU REACH 6 - 7
Y                                  1
Y1    1
Y6   .1    .08      .1    1283    1340    2350   .0125
Y7    0   1340     350    1320     440    1300     730    1283     740    1283
Y7  930   1300    1000    1320    1150    1340
K     2      8                                         1
K1               COMBINE HYDROGRAPHS
K     1      9                                         1
K1               ROUTING THRU REACH 8 - 9
Y                                  1
Y1    1
Y6   .1    .07      .1    1223    1280    3650   .0077
Y7    0   1280     240    1260     410    1240     810    1223     820    1223
Y7 1040   1240    1200    1260    1350    1280
K     1     10                                         1
K1               ROUTING THRU REACH 9 - 10
Y                                  1
Y1    1
Y6   .1    .07      .1    1194    1240    3350   .0047
Y7    0   1240     150    1220     320    1200     940    1194     950    1194
Y7 1200   1200    1280    1220    1400    1240
K     1     11                                         1
K1               ROUTING THRU REACH 10 - 11
Y                                  1
Y1    1
Y6   .1    .07      .1    1183    1240    2550   .0047
Y7    0   1240     360    1220     650    1200     930    1183     940    1183
Y7 1230   1200    1400    1220    1490    1240
K     1     12                                         1
K1               ROUTING THRU REACH 11 - 12
Y                                  1
Y1    1
Y6   .1    .07      .1    1169    1220    2850   .0048
Y7    0   1220     160    1200     300    1180     400    1169     410    1169
Y7  620   1180     700    1200     800    1220
K     1     13                                         1
K1               ROUTING THRU REACH 12 - 13
Y                                  1
Y1    1
Y6   .1    .07      .1    1136    1180    3550   .0033
Y7    0   1180     500    1160     720    1140    1420    1136    1430    1136
Y7 1760   1140    1970    1160    2100    1180
K     1     14                                         1
K1               ROUTING THRU REACH 13 - 14
Y                                  1
Y1    1
Y6   .1    .07      .1    1122    1180    4400   .0033
Y7    0   1180     150    1160     410    1140     820    1122     830    1122
Y7  990   1140    1110    1160    1250    1180
K     1     15                                         1
K1               ROUTING THRU REACH 14 = 15
Y                                  1
Y1    1
Y6   .1    .07      .1    1082    1140    3150   .0154
Y7    0   1140     430    1120     880    1100    1020    1082    1030    1082
Y7 1210   1100    1290    1120    1350    1140
K           16                                         1
K1               INFLOW HYDROGRAPH - WANGAUM FALLS LAKE
M     1      1    7.26            8.39
P         21.5     111     123     133     142
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109          Y7  1210    1100    1290    1120    1350    1140
110          K             16                                    1
111          K1              INFLOW HYDROGRAPH - WANGAUM FALLS LAKE
112          M     1        1    7.36            8.39
113          P            21.5     111     123     133     142
114          T                                                  1     .05
115          W   2.79     .45
116          X   -1.5    -.05       2
117          K     2       17                                    1
118          K1              COMBINE HYDROGRAPHS AT WANGAUM FALLS LAKE
119          K     1       18                                    1
120          K1              RESERVOIR ROUTING - THRU WANGAUM FALLS DAM
121          Y                             1
122          Y1    1                                         168.8      -1
123          Y41056.8    1057  1057.5    1058    1059    1060    1061    1062    1063    1064
124          Y4  1065    1066    1067    1068  1068.5    1069  1069.5    1070  1070.5    1071
125          Y5     0       8     103     260     695    1250    1905    2645    3317    4419
126          Y5  5387    6418    7510    8113    8229    8568    8904    9350   10104   11108
127          $A     0    32.8    43.8   101.9
128          $E1041.6    1057    1060    1080
129          $$1056.8
130          $D1069.1
131          K     99
1                        PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                              RUNOFF HYDROGRAPH AT          1
                              ROUTE HYDROGRAPH TO           2
                              ROUTE HYDROGRAPH TO           3
                              ROUTE HYDROGRAPH TO           4
                              RUNOFF HYDROGRAPH AT          5
                              ROUTE HYDROGRAPH TO           6
                              ROUTE HYDROGRAPH TO           7
                              COMBINE  2 HYDROGRAPHS AT     8
                              ROUTE HYDROGRAPH TO           9
                              ROUTE HYDROGRAPH TO          10
                              ROUTE HYDROGRAPH TO          11
                              ROUTE HYDROGRAPH TO          12
                              ROUTE HYDROGRAPH TO          13
                              ROUTE HYDROGRAPH TO          14
                              ROUTE HYDROGRAPH TO          15
                              RUNOFF HYDROGRAPH AT         16
                              COMBINE  2 HYDROGRAPHS AT    17
                              ROUTE HYDROGRAPH TO          18
                              END OF NETWORK


1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  26 FEB 79
**********************************

 RUN  DATE= 80/03/05.
      TIME= 13.49.52.


                    WANGAUM FALLS DAM     ****     WANGAUM CREEK
                    PAUPACK TWP., WAYNE COUNTY, PA.
                    NDI # PA-00141      PA DER # 64-102

                                                    JOB SPECIFICATION
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WANGAUM FALLS DAM **** WANGAUM CREEK
PAUPACK TWP., WAYNE COUNTY, PA.
NDI # PA-00141 PA DER # 64-102

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .90 .80 .70 .60 .50 .40 .25 .10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - LAKE CLEMO SUBAREA

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.41	0.00	8.39	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= .63 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= .05 RTIOR= 2.00

UNIT HYDROGRAPH 24 END-OF-PERIOD ORDINATES, LAG= .63 HOURS, CP= .45 VOL= 1.00

44.	138.	178.	150.	118.	93.	73.	57.	45.	33.
28.	22.	17.	13.	10.	8.	6.	5.	4.	3.
2.	2.	2.	1.						

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.42	22.04	2.39	23214.
										(620.)(560.)(61.)(657.35)			

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING - THRU LAKE CLERO

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	28.	0

SURFACE AREA=	0.	83.	116.
CAPACITY=	0.	28.	922.
ELEVATION=	1410.	1411.	1420.

CREL	SPVID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1411.0	6.0	2.7	1.5	0.0	0.0	0.0	0.0

PAH DATA

TOPEL	COOD	EXPD	DAMAID
1412.0	2.7	1.5	15.

PEAK OUTFLOW IS 891. AT TIME 41.50 HOURS

PEAK OUTFLOW IS 776. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 686. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 553. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 440. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 328. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 217. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 58. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 8. AT TIME 45.00 HOURS

ROUTING THRU REACH 2 - 3

6/25

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPNP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

ORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0500	.1000	1369.0	1420.0	1850.	.02200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1420.00 450.00 1400.00 630.00 1380.00 700.00 1369.00 760.00 1369.00
800.00 1380.00 1170.00 1400.00 1430.00 1420.00

STORAGE	0.00	8.37	19.30	34.29	51.84	74.63	105.80	145.40	193.40	249.83
	314.66	387.91	469.83	562.24	665.51	779.65	904.65	1040.51	1187.23	1344.82
OUTFLOW	0.00	1497.74	5244.33	11355.53	20106.76	33972.37	51916.86	74235.33	101359.95	133689.60
	171602.20	215460.25	265077.62	321359.16	385427.05	457610.92	538302.20	627910.31	726847.02	835520.50
STAGE	1369.00	1371.68	1374.37	1377.05	1379.74	1382.42	1385.11	1387.79	1390.47	1393.16
	1395.84	1398.53	1401.21	1403.89	1406.58	1409.26	1411.95	1414.63	1417.32	1420.00
FLOW	0.00	1497.74	5244.33	11355.53	20106.76	33972.37	51916.86	74235.33	101359.95	133689.60
	171602.20	215460.25	265077.62	321359.16	385427.05	457610.92	538302.20	627910.31	726847.02	835520.50

XIMUM STAGE IS 1370.6

XIMUM STAGE IS 1370.4

XIMUM STAGE IS 1370.2

XIMUM STAGE IS 1370.0

XIMUM STAGE IS 1369.8

XIMUM STAGE IS 1369.6

XIMUM STAGE IS 1369.4

XIMUM STAGE IS 1369.1

XIMUM STAGE IS 1369.0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

HYDROGRAPH ROUTING

ROUTING THRU REACH 3 - 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	NSPS	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRPT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	SLNTH	SEL
.1000	.0700	.1000	1275.0	1320.0	3900.	.04500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1320.00 280.00 1300.00 320.00 1280.00 340.00 1275.00 350.00 1275.00
380.00 1280.00 550.00 1300.00 680.00 1320.00

STORAGE	0.00	4.63	14.27	29.04	49.11	74.43	105.02	140.89	182.03	228.44
	280.13	337.59	404.36	481.83	569.49	667.27	775.42	893.93	1022.83	1161.87
OUTFLOW	0.00	307.97	1408.94	4019.71	8069.14	13570.63	20976.01	30133.93	41185.34	54571.77
	70128.65	87513.23	107704.68	131669.70	159324.95	190972.81	226885.02	267335.99	312895.33	362927.
STAGE	1275.00	1277.37	1279.74	1282.11	1284.47	1286.84	1289.21	1291.58	1293.95	1296.32
	1298.68	1301.05	1303.42	1305.79	1308.16	1310.53	1312.89	1315.26	1317.63	1320.
FLOW	0.00	307.97	1408.94	4019.71	8069.14	13570.63	20976.01	30133.93	41185.34	54571.
	70128.65	87513.23	107704.68	131669.70	159324.95	190972.81	226885.02	267335.99	312895.33	362927.0

MAXIMUM STAGE IS 1278.6

MAXIMUM STAGE IS 1278.4

MAXIMUM STAGE IS 1278.1

MAXIMUM STAGE IS 1277.9

MAXIMUM STAGE IS 1277.7

MAXIMUM STAGE IS 1277.4

MAXIMUM STAGE IS 1277.1

MAXIMUM STAGE IS 1276.4

MAXIMUM STAGE IS 1275.1

8/25

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - COBB POND SUBAREA

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.72	0.00	8.39	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIOR
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.20 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 44 END-OF-PERIOD ORDINATES, LAG= 1.21 HOURS, CP= .43 VOL= 1.00

14.	33.	105.	151.	173.	167.	146.	128.	113.	99.
87.	76.	67.	59.	51.	45.	40.	35.	30.	27.
23.	21.	18.	16.	14.	12.	11.	9.	8.	7.
6.	6.	5.	4.	4.	3.	3.	3.	2.	2.
2.	2.	1.	1.						

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 24.82 22.34 2.39 415 2.
(630.)(568.)(61.)(1175.0)

HYDROGRAPH ROUTING

RESERVOIR ROUTING - THRU COBB POND

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	307.	0

SURFACE AREA=	0.	37.	57.
CAPACITY=	0.	306.	916.

HYDROGRAPH ROUTING

9125

RESERVOIR ROUTING - THRU COSA POND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	307.	0

SURFACE AREA=	0.	37.	57.
CAPACITY=	0.	306.	916.
ELEVATION=	1302.	1327.	1340.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1327.0	20.0	2.7	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1329.0	2.7	1.5	300.

PEAK OUTFLOW IS 1767. AT TIME 41.25 HOURS

PEAK OUTFLOW IS 1587. AT TIME 41.25 HOURS

PEAK OUTFLOW IS 1406. AT TIME 41.25 HOURS

PEAK OUTFLOW IS 1224. AT TIME 41.25 HOURS

PEAK OUTFLOW IS 1040. AT TIME 41.25 HOURS

PEAK OUTFLOW IS 853. AT TIME 41.50 HOURS

PEAK OUTFLOW IS 657. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 343. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 77. AT TIME 43.75 HOURS

ROUTING THRU REACH 6 - 7

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVT	ELMAX	RLNTH	SEL
.1000	.0800	.1000	1283.0	1340.0	2350.	.01250

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1340.00 350.00 1320.00 446.00 1300.00 730.00 1283.00 740.00 1283.00
930.00 1300.00 1000.00 1320.00 1150.00 1340.00

STORAGE	0.00	8.47	30.66	66.05	116.15	179.46	256.93	338.47	424.90	515.2[illegible]
	609.40	707.48	809.44	917.13	1036.49	1167.99	1311.62	1467.40	1635.33	1815.3[illegible]
OUTFLOW	0.00	457.50	2547.71	7164.85	15059.10	26901.22	44733.83	70337.90	[illegible]	[illegible]
	175456.87	219689.95	265467.70	320539.74	377788.66	441040.88	510503.04	[illegible]	[illegible]	[illegible]
STAGE	1283.00	1286.00	1289.00	1292.00	1295.00	1298.00	1301.00	[illegible]	[illegible]	[illegible]
	1313.00	1316.00	1319.00	1322.00	1325.00	1328.00	1331.00	[illegible]	[illegible]	[illegible]
FLOW	0.00	457.50	2547.71	7164.83	15059.10	26901.22	44733.83	70337.90	[illegible]	[illegible]
	175456.87	219689.95	265467.70	320539.74	377788.66	441040.88	510503.04	[illegible]	[illegible]	[illegible]

MAXIMUM STAGE IS 1287.9

MAXIMUM STAGE IS 1287.6

MAXIMUM STAGE IS 1287.3

MAXIMUM STAGE IS 1287.1

MAXIMUM STAGE IS 1286.8

MAXIMUM STAGE IS 1286.6

MAXIMUM STAGE IS 1286.3

MAXIMUM STAGE IS 1285.2

MAXIMUM STAGE IS 1283.5

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
8	2	0	0	0	0	1	0	0

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HYDROGRAPH ROUTING

ROUTING THRU REACH 8 - 9

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
9	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVT	ELMAX	RLNTH	SEL
.1000	.0700	.1000	1223.0	1290.0	3650.	.00770

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1280.00 240.00 1260.00 410.00 1240.00 810.00 1223.00 820.00 1223.00
1040.00 1240.00 1200.00 1260.00 1350.00 1280.00

STORAGE	0.00	16.27	60.03	131.31	230.05	356.36	507.61	679.05	85
	1258.92	1477.43	1708.38	1952.26	2210.76	2483.94	2771.83	3074.43	339
OUTFLOW	0.00	500.77	2861.17	8125.86	17167.84	31766.81	51137.48	80243.41	11.1.
	203772.35	256157.25	314300.51	378050.93	447710.44	523514.13	6035?9.07	694026.90	788?3
STAGE	1223.00	1226.00	1229.00	1232.00	1235.00	1238.00	1241.00	1244.00	124
	1253.00	1256.00	1259.00	1262.00	1265.00	1268.00	1271.00	1274.00	127
FLOW	0.00	500.77	2861.17	8125.86	17167.84	31766.81	51137.48	80243.41	11?41
	203772.35	256157.25	314300.51	378050.93	447710.44	523514.13	603?9.07	694026.90	788?3.

MAXIMUM STAGE IS 1228.7

MAXIMUM STAGE IS 1228.3

MAXIMUM STAGE IS 1227.9

MAXIMUM STAGE IS 1227.6

MAXIMUM STAGE IS 1227.2

HYDROGRAPH ROUTING

ROUTING THRU REACH 8 - 9

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
9	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0700	.1000	1223.0	1290.0	3650.	.00770

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1280.00 240.00 1260.00 410.00 1240.00 810.00 1223.00 820.00 1223.00
1040.00 1240.00 1200.00 1260.00 1350.00 1280.00

STORAGE	0.00	15.27	60.03	131.31	230.09	358.36	518.01	678.05	859.23	1062.57
	1258.92	1477.43	1708.38	1952.28	2210.76	2483.94	2771.83	3074.43	3391.76	3723.74
OUTFLOW	0.00	500.77	2861.17	8125.86	17167.84	30766.81	51267.48	80840.41	122134.33	179102.93
	203772.35	256157.25	314300.51	378050.93	447710.44	523514.13	605579.07	694026.90	788781.70	890538.4
STAGE	1223.00	1226.00	1229.00	1232.00	1235.00	1238.00	1241.00	1244.00	1247.00	1250.0
	1253.00	1256.00	1259.00	1262.00	1265.00	1268.00	1271.00	1274.00	1277.00	1280.0
FLOW	0.00	500.77	2861.17	8125.86	17167.84	30766.81	51267.48	80840.41	122134.33	179102.9
	203772.35	256157.25	314300.51	378050.93	447710.44	523514.13	605579.07	694026.90	788781.70	890538.4

MAXIMUM STAGE IS 1228.7

MAXIMUM STAGE IS 1228.3

MAXIMUM STAGE IS 1227.9

MAXIMUM STAGE IS 1227.6

MAXIMUM STAGE IS 1227.2

MAXIMUM STAGE IS 1226.8

MAXIMUM STAGE IS 1226.4

MAXIMUM STAGE IS 1226.2

MAXIMUM STAGE IS 1225.5

HYDROGRAPH ROUTING

13/25

ROUTING THRU REACH 9 - 10

ISTAQ	ICOMP	ICON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
10	1	0	0	0	0	1	1	1

ROUTING DATA

OLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSAK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVT	ELMAX	RLNTH	SEL
.1000	.0700	.1000	1194.0	1240.0	3350.	.00470

CROSS SECTION COORDINATES--STA,ELEV,STA-ELEV--ETC
0.00 1240.00 150.00 1220.00 320.00 1200.00 940.00 1194.00 950.00 1194.00
1200.00 1200.00 1280.00 1220.00 1400.00 1240.00

STORAGE	0.00	34.54	134.45	291.89	461.20	638.44	817.31	1003.82	1195.97	1393.7
	1597.16	1806.23	2021.26	2242.37	2469.57	2702.85	2942.22	3187.68	3439.22	3696.8
OUTFLOW	0.00	758.12	4642.47	14592.35	30844.12	51795.43	77102.89	106547.34	139978.89	177287.1
	218395.32	263225.69	311724.17	363917.34	419783.92	479310.77	542490.89	609322.14	679806.28	753943.3
STAGE	1194.00	1196.42	1198.84	1201.26	1203.68	1206.11	1208.53	1210.95	1213.37	1215.7
	1218.21	1220.63	1223.05	1225.47	1227.89	1230.32	1232.74	1235.16	1237.58	1240.0
FLOW	0.00	758.12	4642.47	14592.35	30844.12	51795.43	77102.89	106547.34	139978.89	177287.1
	218395.32	263225.69	311724.17	363917.34	419783.92	479310.77	542490.89	609322.14	679806.28	753943.3

MAXIMUM STAGE IS 1197.5

MAXIMUM STAGE IS 1197.4

MAXIMUM STAGE IS 1197.2

MAXIMUM STAGE IS 1197.0

MAXIMUM STAGE IS 1196.8

MAXIMUM STAGE IS 1196.6

MAXIMUM STAGE IS 1196.4

(UM STAGE IS 1195.1

MAXIMUM STAGE IS 1194.3

HYDROGRAPH ROUTING

14/25

ROUTING THRU REACH 10 - 11

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
11	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	10	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELEVT	ELMAX	RLNTH	SEL
.1000	.0700	.1000	1183.0	1240.0	2550.	.00470

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1240.00 360.00 1220.00 650.00 1200.00 930.00 1183.00 940.00 1183.00
1230.00 1200.00 1400.00 1220.00 1490.00 1240.00

STORAGE	0.00	10.59	38.84	84.76	148.33	229.60	328.20	440.16	564.24	700.4[illegible]
	848.74	1009.17	1181.72	1366.32	1562.80	1771.13	1991.31	2223.33	2467.24	2722.99
OUTFLOW	0.00	366.04	2074.84	5874.98	12392.74	22187.65	36962.95	56331.21	8[illegible]	114272.6
	149033.09	188459.64	232666.04	281806.26	336003.18	395346.02	459943.09	529907.47	6[illegible]	6[illegible]
STAGE	1183.00	1186.00	1189.00	1192.00	1195.00	1198.00	1201.00	1204.00	1207.[illegible]	121[illegible]
	1213.00	1216.00	1219.00	1222.00	1225.00	1228.00	1231.00	1234.00	1237.00	1240.[illegible]
FLOW	0.00	366.04	2074.84	5874.98	12392.74	22187.65	36962.95	56331.21	84371.33	114272.6[illegible]
	149033.09	188459.64	232666.04	281806.26	336003.18	395346.02	459943.09	529907.47	608383.00	686403.1[illegible]

MAXIMUM STAGE IS 1189.4

MAXIMUM STAGE IS 1189.1

MAXIMUM STAGE IS 1188.8

MAXIMUM STAGE IS 1188.3

MAXIMUM STAGE IS 1187.8

MAXIMUM STAGE IS 1187.3

MAXIMUM STAGE IS 1186.7

MAXIMUM STAGE IS 1185.8

MAXIMUM STAGE IS 1183.7

HYDROGRAPH ROUTING

ROUTING THRU REACH 11 - 12

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
12	1	0	9	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0700	.1000	1169.0	1220.0	2650.	.00480

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1220.00 160.00 1200.00 300.00 1160.00 400.00 1169.00 410.00 1169.00
620.00 1180.00 700.00 1200.00 800.00 1220.00

STORAGE	0.00	8.40	30.08	65.05	113.30	171.55	235.02	303.67	377.51	456.33
	540.74	630.14	724.81	825.48	932.27	1045.19	1164.23	1289.41	1420.71	1558.1[illegible]
OUTFLOW	0.00	247.51	1360.74	3807.58	7981.33	15403.45	25041.31	36724.22	50436.56	66187.[illegible]
	83985.79	103854.23	125750.83	149732.50	175944.37	204436.86	235261.21	268469.11	304112.39	342242.9[illegible]
STAGE	1169.00	1171.68	1174.37	1177.05	1179.74	1182.42	1185.11	1187.79	1190.47	1193.1[illegible]
	1195.84	1198.53	1201.21	1203.89	1206.58	1209.26	1211.95	1214.63	1217.32	1220.0[illegible]
FLOW	0.00	247.51	1360.74	3807.58	7981.33	15403.45	25041.31	36724.22	50436.56	66187.[illegible]
	83985.79	103854.23	125750.83	149732.50	175944.37	204436.86	235261.21	268469.11	304112.39	342242.9[illegible]

[illegible]XIMUM STAGE IS 1175.7

[illegible]XIMUM STAGE IS 1175.3

[illegible]XIMUM STAGE IS 1175.0

[illegible]AXIMUM STAGE IS 1174.7

[illegible]AXIMUM STAGE IS 1174.4

[illegible]AXIMUM STAGE IS 1173.7

[illegible]AXIMUM STAGE IS 1173.[illegible]

[illegible] M STAGE IS 1171.9

[illegible]AXIMUM STAGE IS 1169.9

ROUTING THRU REACH 12 - 13

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
13	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0700	.1000	1136.0	1180.0	3550.	.00330

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1180.00 500.00 1160.00 720.00 1140.00 1420.00 1136.00 1430.00 1136.00
1760.00 1140.00 1970.00 1160.00 2100.00 1180.00

STORAGE	0.00	58.16	225.02	428.56	641.50	863.83	1095.56	1336.69	1587.21	1847.13
	2116.45	2396.05	2689.12	2995.97	3316.58	3650.96	3999.11	4361.02	4736.70	5126.15
OUTFLOW	0.00	972.72	6458.23	18488.36	35277.43	56406.15	81638.85	110828.25	143877.74	180722.67
	221321.10	265322.78	313087.05	364828.36	420559.13	480311.40	544127.42	612055.26	684148.59	760455.44
STAGE	1136.00	1138.32	1140.65	1142.95	1145.26	1147.58	1149.89	1152.21	1154.53	1156.84
	1159.16	1161.47	1163.79	1166.11	1168.42	1170.74	1173.05	1175.37	1177.68	1180.00
FLOW	0.00	972.72	6458.23	18488.36	35277.43	56406.15	81638.85	110828.25	143877.74	180722.67
	221321.10	265322.78	313087.05	364828.36	420559.13	480311.40	544127.42	612055.26	684148.59	760455.44

MAXIMUM STAGE IS 1138.9

MAXIMUM STAGE IS 1138.8

MAXIMUM STAGE IS 1138.7

MAXIMUM STAGE IS 1138.6

MAXIMUM STAGE IS 1138.5

MAXIMUM STAGE IS 1138.3

MAXIMUM STAGE IS 1137.7

MAXIMUM STAGE IS 1134.8

MAXIMUM STAGE IS 1136.2

HYDROGRAPH ROUTING

ROUTING THRU REACH 13 - 14

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
14	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0700	.1000	1122.0	1180.0	4400.	.00330

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1160.00 150.00 1150.00 410.00 1140.00 820.00 1122.00 820.00 1122.00
990.00 1140.00 1110.00 1160.00 1250.00 1180.00

STORAGE	0.00	17.99	65.78	143.38	250.79	388.00	554.96	744.59	952.11	1177.51
	1420.80	1681.97	1961.02	2257.31	2567.68	2891.70	3229.38	3580.67	3945.63	4324.27
OUTFLOW	0.00	305.96	1727.50	4884.14	10294.50	18422.01	30019.26	47981.33	70114.13	94743.31
	123685.00	156395.90	192941.25	233583.23	278288.33	326904.75	379457.66	435979.97	495510.00	561090.31
STAGE	1122.00	1125.05	1128.11	1131.16	1134.21	1137.26	1140.32	1143.37	1146.42	1149.4
	1152.53	1155.58	1158.63	1161.68	1164.74	1167.79	1170.84	1173.89	1176.95	1180.0
FLOW	0.00	305.96	1727.50	4884.14	10294.50	18422.01	30019.26	47981.33	70114.13	94743.3
	123685.00	156395.90	192941.25	233583.23	278288.33	326904.75	379457.66	435979.97	495510.00	561090..

MAXIMUM STAGE IS 1128.8

MAXIMUM STAGE IS 1128.5

MAXIMUM STAGE IS 1128.2

MAXIMUM STAGE IS 1127.8

MAXIMUM STAGE IS 1127.2

MAXIMUM STAGE IS 1126.5

MAXIMUM STAGE IS 1125.9

MAXIMUM STAGE IS 1125.0

MAXIMUM STAGE IS 1122.8

ROUTING THRU REACH 14 = 15

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
15	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVT	ELMAX	RLNTH	SEL
.1000	.0700	.1000	1082.0	1140.0	3150.	.01540

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1140.00 430.00 1120.00 880.00 1100.00 1020.00 1082.00 1030.00 1082.00
1210.00 1100.00 1290.00 1120.00 1350.00 1140.00

STORAGE	0.00	8.20	28.37	60.53	104.67	160.78	228.91	312.54	414.02	533.3.
	670.55	825.60	998.51	1189.07	1396.28	1620.08	1860.22	2116.9.	2390.20	2679.9.
OUTFLOW	0.00	435.55	2293.12	6304.68	13090.41	23206.46	37567.03	59941.88	87530.64	121021.7
	160687.20	207004.43	260373.53	321351.25	390186.25	467035.00	552208.18	646012.79	748751.94	860724.8
STAGE	1082.00	1085.03	1088.11	1091.16	1094.21	1097.26	1100.32	1103.37	1106.42	1109.4
	1112.53	1115.58	1118.63	1121.68	1124.74	1127.79	1130.84	1133.89	1136.95	1140.0
FLOW	0.00	435.55	2293.12	6304.68	13090.41	23206.46	37567.03	59941.88	87530.64	121021.4
	160687.20	207004.43	260373.53	321351.25	390186.25	467035.00	552208.18	646012.79	748751.94	860724.8

MAXIMUM STAGE IS 1088.2

MAXIMUM STAGE IS 1087.9

MAXIMUM STAGE IS 1087.4

MAXIMUM STAGE IS 1086.9

MAXIMUM STAGE IS 1086.4

MAXIMUM STAGE IS 1085.9

MAXIMUM STAGE IS 1085.4

MAXIMUM STAGE IS 1084.1

MAXIMUM STAGE IS 1082.6

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - WANGANUM FALLS LAK

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
16	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	7.26	0.00	8.39	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CRVTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 2.79 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 99 END-OF-PERIOD ORDINATES, LAG= 2.81 HOURS, CP= .45 VOL= 1.00

18.	69.	141.	228.	324.	428.	531.	621.	692.	744.
774.	774.	743.	701.	662.	626.	591.	558.	527.	498.
470.	444.	420.	396.	374.	354.	334.	315.	298.	281.
266.	251.	237.	224.	212.	200.	189.	178.	168.	159.
150.	142.	134.	127.	120.	113.	107.	101.	95.	90.
85.	80.	76.	72.	68.	64.	60.	57.	54.	51.
48.	45.	43.	40.	38.	36.	34.	32.	30.	29.
27.	26.	24.	23.	22.	20.	19.	18.	17.	16.
15.	14.	14.	13.	12.	12.	11.	10.	10.	9.
9.	8.	8.	7.	7.	7.	6.	6.	5.	

0 END-OF-PERIOD FLOW

NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 24.42 22.04 2.39 411863.
(620.)(559.)(61.)(11662.66)

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COMBINE HYDROGRAPHS

COMBINE HYDROGRAPHS AT WANGANUM FALLS LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
17	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

HYDROGRAPH ROUTING

RESERVOIR ROUTING - THRU WANGAUM FALLS DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
18	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	10	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	169.	-1

STAGE	1056.80	1057.00	1057.50	1058.00	1059.00	1060.00	1061.00	1062.00	1063.00	1064.00
	1065.00	1066.00	1067.00	1068.00	1068.50	1069.00	1069.50	1070.00	1070.50	1071.00
FLOW	0.00	8.00	103.00	260.00	695.00	1250.00	1905.00	2645.00	3517.00	4419.00
	5387.00	6418.00	7510.00	8113.00	8229.00	8368.00	8904.00	9350.00	10104.00	11108.0

SURFACE AREA=	0.	33.	44.	102.
CAPACITY=	0.	168.	283.	1700.
ELEVATION=	1042.	1057.	1060.	1080.

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1056.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1069.1	0.0	0.0	0.

PEAK OUTFLOW IS 13401. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 11911. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 10251. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 8601. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 7534. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 6118. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 4723. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 2935. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 1101. AT TIME 43.50 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .90	RATIO 3 .80	RATIO 4 .70	RATIO 5 .60	RATIO 6 .50	RATIO 7 .40	RATIO 8 .25	RATIO 9 .10
HYDROGRAPH AT	1	.41	1	1453.	1307.	1162.	1017.	872.	726.	581.	363.	145.
		(1.06)		(41.13)(	37.02)(	32.91)(	28.79)(	24.68)(	20.57)(	16.45)(	10.28)(	4.11)
ROUTED TO	2	.41	1	891.	778.	666.	553.	440.	328.	217.	58.	8.
		(1.06)		(25.24)(	22.04)(	18.86)(	15.66)(	12.47)(	9.30)(	6.15)(	1.65)(	.22)
ROUTED TO	3	.41	1	891.	779.	665.	553.	441.	328.	217.	58.	8.
		(1.06)		(25.22)(	22.05)(	18.83)(	15.66)(	12.47)(	9.30)(	6.15)(	1.65)(	.22)
ROUTED TO	4	.41	1	890.	777.	665.	551.	440.	328.	215.	58.	8.
		(1.06)		(25.21)(	21.99)(	18.83)(	15.61)(	12.45)(	9.29)(	6.10)(	1.64)(	.23)
HYDROGRAPH AT	5	.72	1	1837.	1653.	1470.	1286.	1102.	919.	735.	459.	184.
		(1.86)		(52.02)(	46.82)(	41.62)(	36.42)(	31.21)(	26.01)(	20.81)(	13.01)(	5.20)
ROUTED TO	6	.72	1	1767.	1587.	1406.	1224.	1040.	853.	657.	343.	77.
		(1.86)		(50.04)(	44.93)(	39.80)(	34.65)(	29.44)(	24.16)(	18.61)(	9.72)(	2.19)
ROUTED TO	7	.72	1	1753.	1575.	1397.	1218.	1037.	851.	657.	339.	77.
		(1.86)		(49.64)(	44.61)(	39.56)(	34.49)(	29.37)(	24.09)(	18.59)(	9.59)(	2.18)
2 COMBINED	8	1.13	1	2634.	2339.	2042.	1742.	1446.	1137.	837.	386.	85.
		(2.93)		(74.59)(	66.24)(	57.83)(	49.33)(	40.94)(	32.20)(	23.70)(	10.92)(	2.40)
ROUTED TO	9	1.13	1	2605.	2314.	2020.	1725.	1433.	1129.	830.	373.	84.
		(2.93)		(73.78)(	65.52)(	57.21)(	48.86)(	40.58)(	31.97)(	23.49)(	10.57)(	2.38)
ROUTED TO	10	1.13	1	2550.	2269.	1984.	1697.	1403.	1106.	795.	333.	83.
		(2.93)		(72.21)(	64.24)(	56.19)(	48.05)(	39.74)(	31.33)(	22.51)(	10.00)(	2.35)
ROUTED TO	11	1.13	1	2546.	2261.	1971.	1686.	1394.	1099.	787.	347.	83.
		(2.93)		(72.10)(	64.03)(	55.82)(	47.75)(	39.46)(	31.11)(	22.29)(	9.82)(	2.34)
ROUTED TO	12	1.13	1	2534.	2252.	1959.	1678.	1383.	1087.	778.	344.	82.
		(2.93)		(71.77)(	63.76)(	55.48)(	47.51)(	39.15)(	30.77)(	22.02)(	9.74)(	2.32)
ROUTED TO	13	1.13	1	2471.	2194.	1910.	1627.	1331.	1008.	715.	321.	80.
		(2.93)		(69.98)(	62.12)(	54.09)(	46.08)(	37.70)(	28.46)(	20.23)(	9.08)(	2.27)
ROUTED TO	14	1.13	1	2435.	2152.	1872.	1575.	1285.	973.	699.	304.	79.
		(2.93)		(68.95)(	60.94)(	53.02)(	44.60)(	36.39)(	27.56)(	19.78)(	8.60)(	2.23)
ROUTED TO	15	1.13	1	2427.	2150.	1864.	1569.	1282.	970.	697.	302.	79.
		(2.93)		(68.73)(	60.89)(	52.77)(	44.44)(	36.30)(	27.48)(	19.73)(	8.55)(	2.23)
HYDROGRAPH AT	16	7.26	1	11621.	10459.	9297.	8135.	6973.	5810.	4648.	2905.	1162.
		(18.80)		(329.07)(	296.16)(	263.25)(	230.35)(	197.44)(	164.53)(	131.63)(	82.27)(	32.91)

2 COMBINED	1	8.39	1	13786.	12291.	10797.	9320.	7794.	6311.	4834.	2967.	110
	(	21.73)	(	390.38)(	348.04)(	305.73)(	263.92)(	220.70)(	178.71)(	136.89)(	84.00)(	33.40)
ROUTED TO	18	8.39	1	13401.	11911.	10251.	8601.	7534.	6118.	4723.	2835.	1101.
	(	21.73)	(	379.48)(	337.29)(	290.29)(	243.56)(	213.35)(	173.25)(	133.73)(	80.27)(	31.17)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1410.99	1411.00	1412.00
STORAGE	27.	28.	113.
OUTFLOW	0.	0.	22.

LAKE ELLIS

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1413.58	1.58	254.	891.	18.50	41.50	0.00
.90	1413.44	1.44	241.	778.	18.00	41.75	0.00
.80	1413.29	1.29	227.	666.	17.25	41.75	0.00
.70	1413.13	1.13	213.	553.	16.75	42.00	0.00
.60	1412.96	.96	198.	440.	15.75	42.25	0.00
.50	1412.78	.78	181.	328.	14.75	42.25	0.00
.40	1412.57	.57	163.	217.	14.00	42.50	0.00
.25	1412.18	.18	128.	58.	9.75	43.50	0.00
.10	1411.51	0.00	71.	8.	0.00	45.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	891.	1370.6	41.75
.90	779.	1370.4	41.75
.80	665.	1370.2	41.75
.70	553.	1370.0	42.00
.60	441.	1369.8	42.25
.50	328.	1369.6	42.50
.40	217.	1369.4	42.75
.25	58.	1369.1	43.75
.10	8.	1369.0	45.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	890.	1278.6	41.75
.90	777.	1278.4	41.75
.80	665.	1278.1	42.00
.70	551.	1277.9	42.00
.60	440.	1277.7	42.25
.50	328.	1277.4	42.50
.40	215.	1276.7	43.00
.25	58.	1275.4	43.75
.10	8.	1275.1	45.25

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1327.01	1327.00	1329.00
STORAGE	307.	306.	383.
OUTFLOW	0.	0.	153.

COBB POND

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.00	1330.45	1.45	443.	1767.	10.75	41.25	0.00
.90	1330.34	1.34	438.	1587.	10.25	41.25	0.00
.80	1330.22	1.22	433.	1406.	9.75	41.25	0.00
.70	1330.10	1.10	428.	1224.	9.00	41.25	0.00
.60	1329.96	.96	423.	1040.	8.50	41.25	0.00
.50	1329.82	.82	417.	853.	7.50	41.50	0.00
.40	1329.65	.65	410.	657.	6.50	41.75	0.00
.25	1329.33	.33	397.	343.	4.25	42.50	0.00
.10	1328.27	0.00	355.	77.	0.00	43.75	0.00

PLAN 1 STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1753.	1287.9	41.50
.90	1575.	1287.6	41.50
.80	1397.	1287.3	41.50
.70	1218.	1287.1	41.50
.60	1037.	1286.8	41.50
.50	851.	1286.6	41.50
.40	657.	1286.3	41.75
.25	339.	1285.2	42.75
.10	77.	1283.5	44.00

PLAN 1 STATION 9

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2605.	1228.7	41.75
.90	2314.	1228.3	41.75
.80	2020.	1227.9	41.75
.70	1725.	1227.6	42.00
.60	1433.	1227.2	42.00
.50	1129.	1226.8	42.25
.40	830.	1226.4	42.25
.25	373.	1225.2	43.25
.10	84.	1223.5	44.50

PLAN 1 STATION 10

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2550.	1197.5	42.25
.90	2269.	1197.4	42.25

PLAN 1 STATION 10

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2550.	1197.5	42.25
.90	2269.	1197.4	42.25
.80	1984.	1197.2	42.25
.70	1697.	1197.0	42.25
.60	1403.	1196.8	42.50
.50	1106.	1196.6	42.50
.40	795.	1196.4	43.00
.25	353.	1195.1	44.00
.10	83.	1194.3	45.25

PLAN 1 STATION 11

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2546.	1189.4	42.25
.90	2261.	1189.1	42.25
.80	1971.	1188.8	42.50
.70	1686.	1188.3	42.50
.60	1394.	1187.8	42.50
.50	1099.	1187.3	42.75
.40	787.	1186.7	43.25
.25	347.	1185.8	44.25
.10	83.	1183.7	45.50

PLAN 1 STATION 12

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2534.	1175.7	42.50
.90	2252.	1175.3	42.50
.80	1959.	1175.0	42.75
.70	1678.	1174.7	42.75
.60	1383.	1174.4	42.75
.50	1087.	1173.7	43.00
.40	778.	1173.0	43.50
.25	344.	1171.9	44.50
.10	82.	1169.9	46.00

PLAN 1 STATION 13

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2471.	1138.9	43.00
.90	2194.	1138.8	43.00
.80	1910.	1138.7	43.00
.70	1627.	1138.6	43.25
.60	1331.	1138.5	43.50
.50	1005.	1138.3	43.75
.40	715.	1137.7	44.25
.25	321.	1136.6	45.25
.10	[illegible]	[illegible]	[illegible]

.80	1910.	1138.7	43.00
.70	1627.	1138.6	43.25
.60	1331.	1138.5	43.50
.50	1005.	1138.3	43.75
.40	715.	1137.7	44.25
.25	321.	1136.8	45.25
.10	80.	1136.2	46.75

PLAN 1 STATION 14

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2435.	1128.8	43.25
.90	2152.	1128.5	43.25
.80	1872.	1128.2	43.50
.70	1575.	1127.8	43.75
.60	1265.	1127.2	44.00
.50	973.	1126.5	44.25
.40	699.	1125.9	44.75
.25	304.	1125.0	46.00
.10	79.	1122.8	47.50

PLAN 1 STATION 15

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2427.	1088.2	43.50
.90	2150.	1087.9	43.50
.80	1864.	1087.4	43.75
.70	1569.	1086.9	43.75
.60	1282.	1086.4	44.00
.50	970.	1085.9	44.50
.40	697.	1085.5	45.00
.25	302.	1084.1	46.25
.10	79.	1082.6	47.75

1

SUMMARY OF DAM SAFETY ANALYSIS

WANGAUM FALLS

PLAN 1 .....

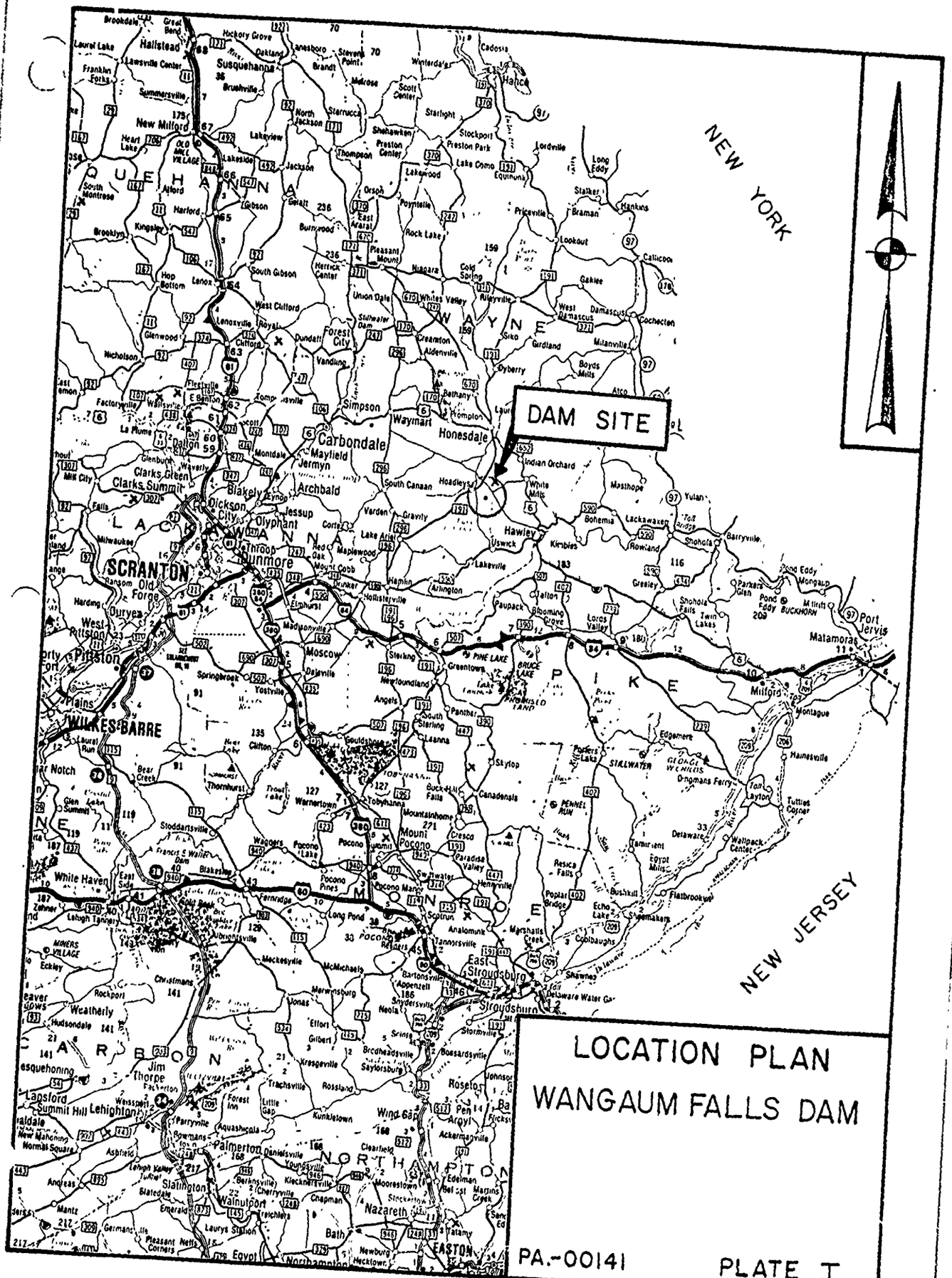
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1057.01	1056.80	1069.10
STORAGE	169.	162.	784.
OUTFLOW	10.	0.	8035.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1072.14	3.04	1002.	13402.	4.75	43.50	0.00
.90	1071.40	2.30	947.	11911.	4.00	43.50	0.00
.80	1070.57	1.47	887.	10251.	3.00	43.75	0.00
.70	1069.05	0.00	781.	8601.	0.00	44.00	0.00
.60	1067.04	0.00	652.	7534.	0.00	43.75	0.00
.50	1065.71	0.00	572.	6118.	0.00	43.75	0.00
.40	1064.31	0.00	494.	4723.	0.00	43.75	0.00
.25	1062.22	0.00	386.	2835.	0.00	43.50	0.00
.10	1059.73	0.00	271.	1101.	0.00	43.50	0.00

EOI ENCOUNTERED.

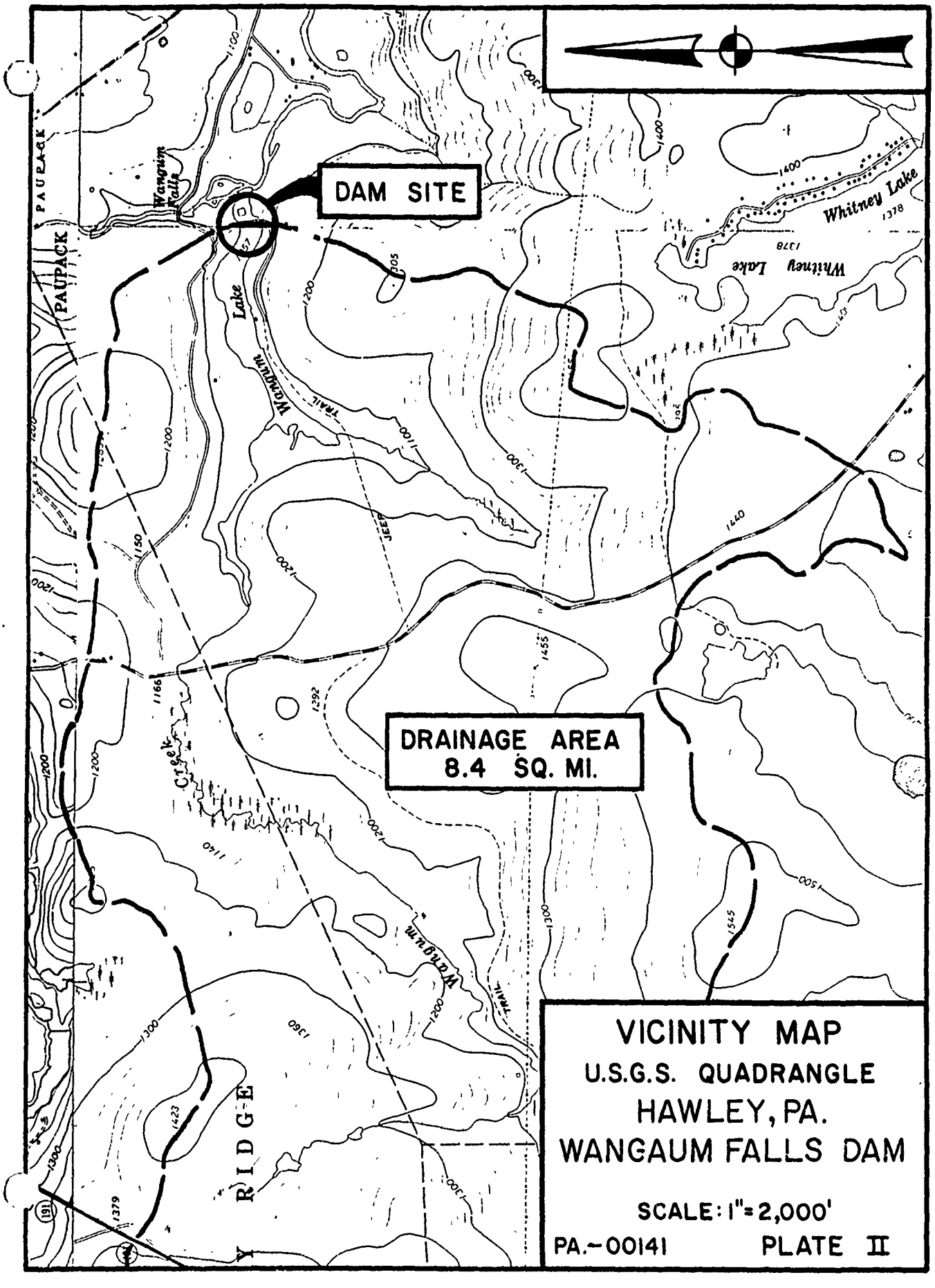
APPENDIX E

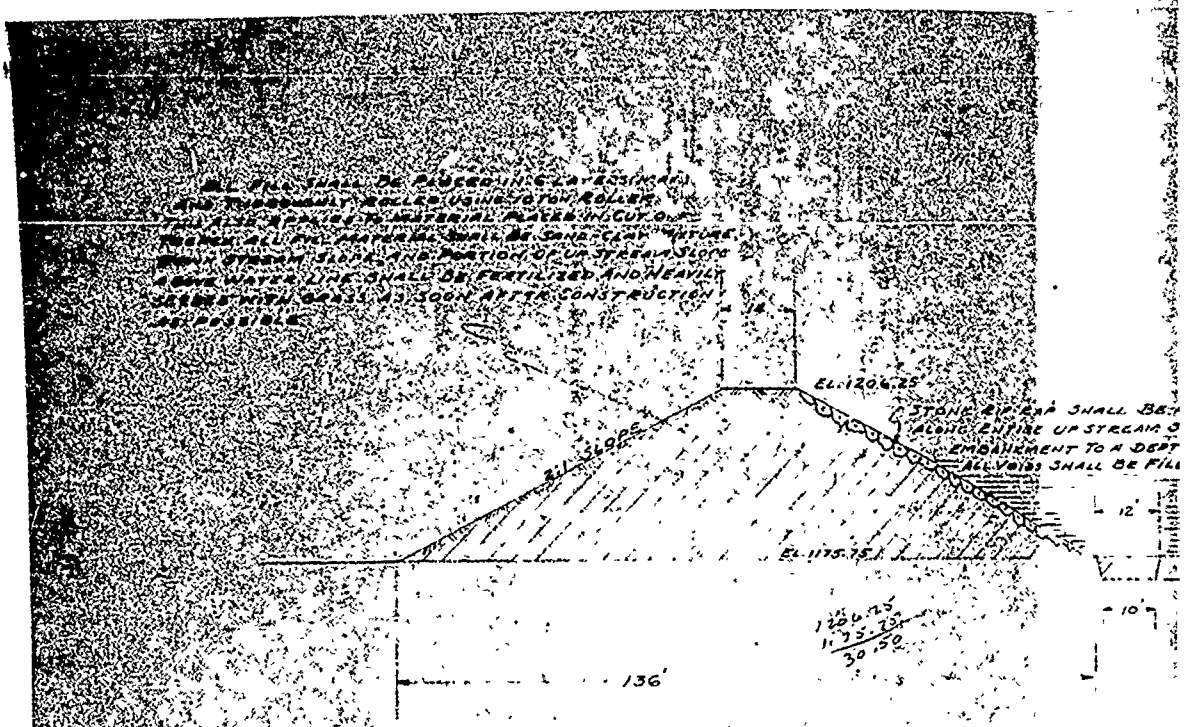
PLATES



LOCATION PLAN
WANGAUM FALLS DAM

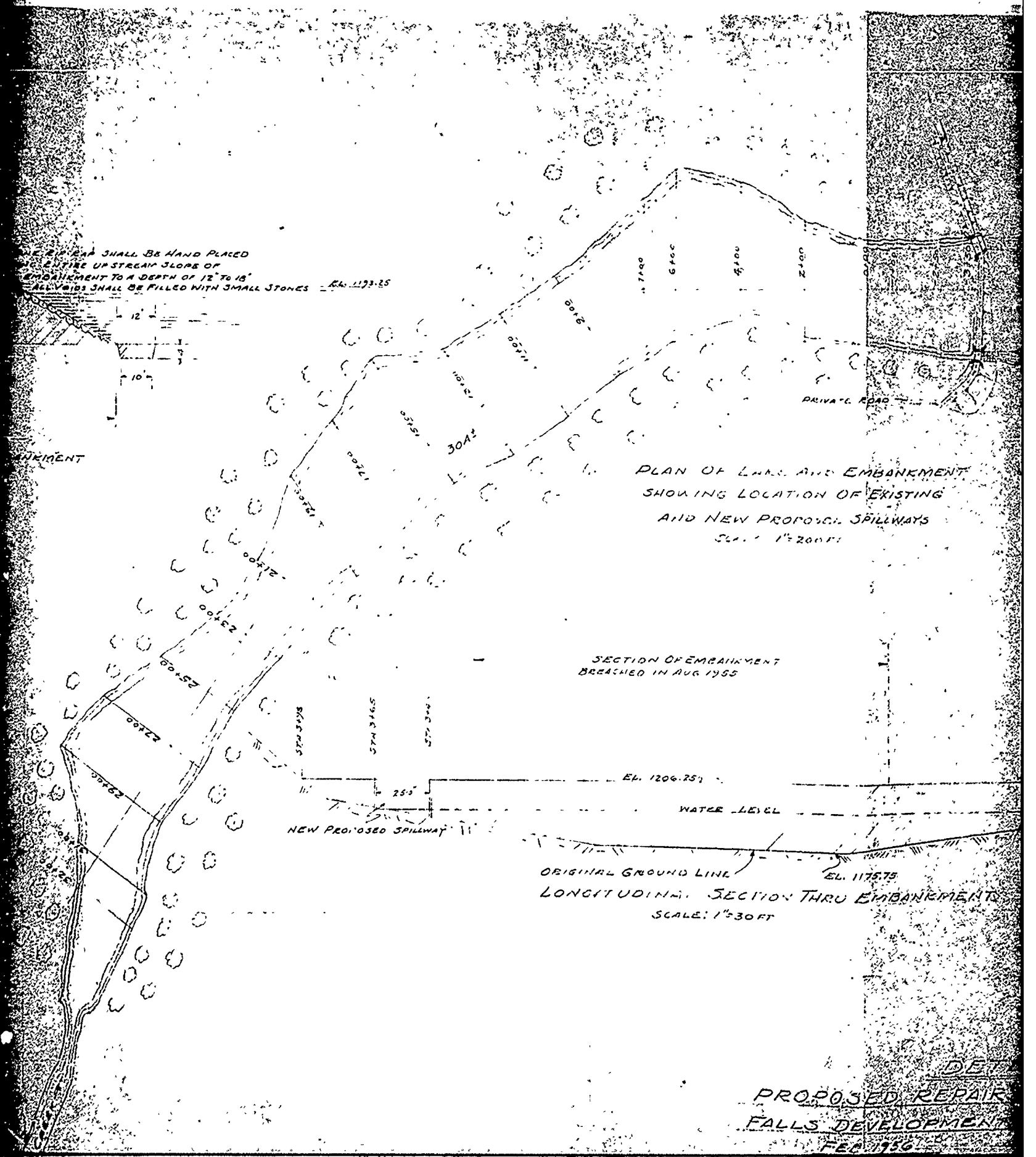
PA.-00141 PLATE I

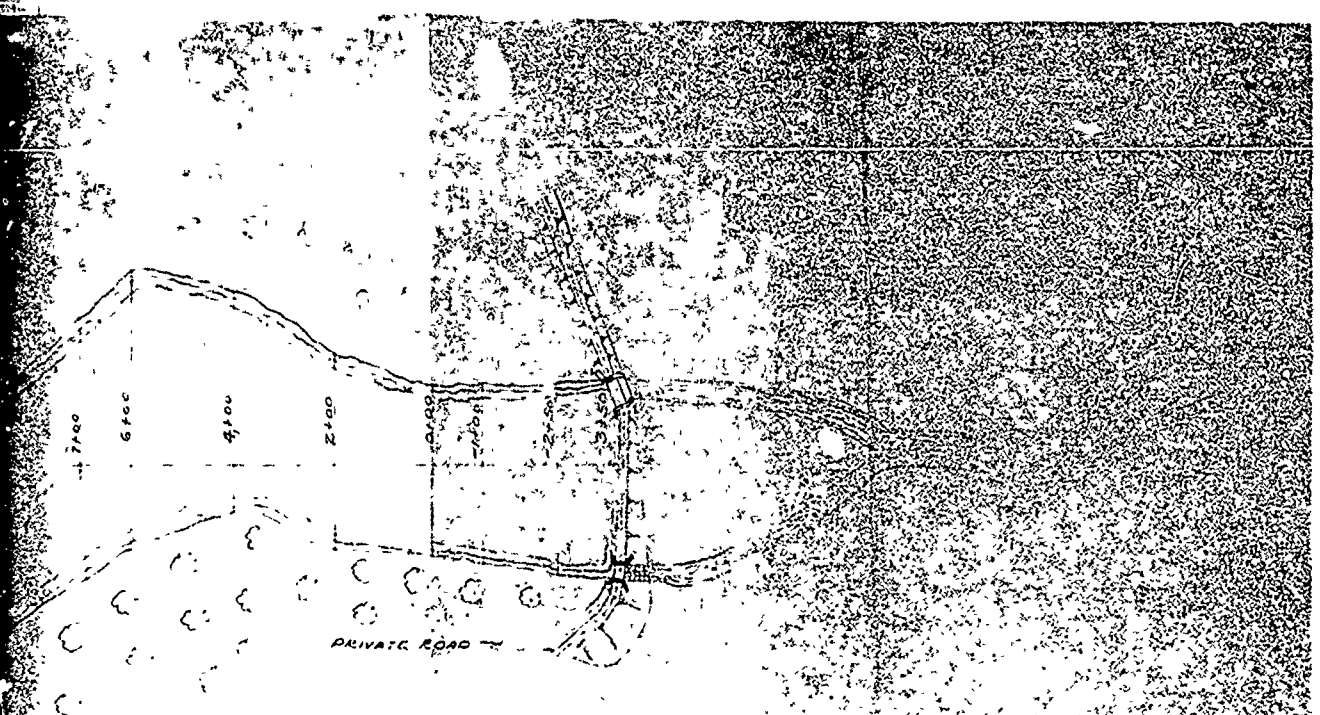

DAM SITE
DRAINAGE AREA
8.4 SQ. MI.
PAUPACK
Wangum Falls
Lake Wangum
Whitney Lake
Whitney Lake
TRAIL
JEEP
TRAIL
RIDGE
Creek
VICINITY MAP
U.S.G.S. QUADRANGLE
HAWLEY, PA.
WANGAUM FALLS DAM
SCALE: 1"=2,000'
PA.-00141
PLATE II



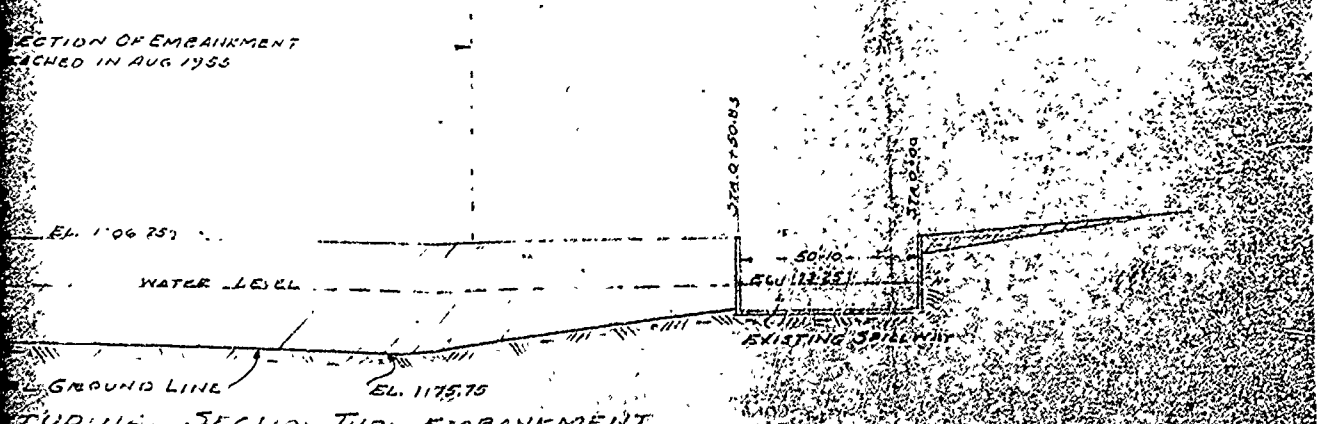
TYPICAL SECTION THRU DAM EMBANKMENT

SCALE: 1" = 20 FT


RIP-RAP SHALL BE HAND PLACED
ON ENTIRE UPSTREAM SLOPE OF
EMBANKMENT TO A DEPTH OF 12" TO 18"
ALL VOIDS SHALL BE FILLED WITH SMALL STONES
EL. 1193.25
12'
10'
PRIVATE ROAD
PLAN OF LAKE AND EMBANKMENT
SHOWING LOCATION OF EXISTING
AND NEW PROPOSED SPILLWAYS
SCALE 1"=200 FT
SECTION OF EMBANKMENT
BREACHED IN AUG 1955
EL. 1206.25
25'
WATER LEVEL
NEW PROPOSED SPILLWAY
ORIGINAL GROUND LINE
EL. 1175.75
LONGITUDINAL SECTION THRU EMBANKMENT
SCALE: 1"=30 FT
PROPOSED REPAIR
FALLS DEVELOPMENT
FEB 1956



PLAN OF LAKE AND EMBANKMENT
SHOWING LOCATION OF EXISTING
AND NEW PROPOSED SPILLWAYS
SCALE: 1"=200 FT.



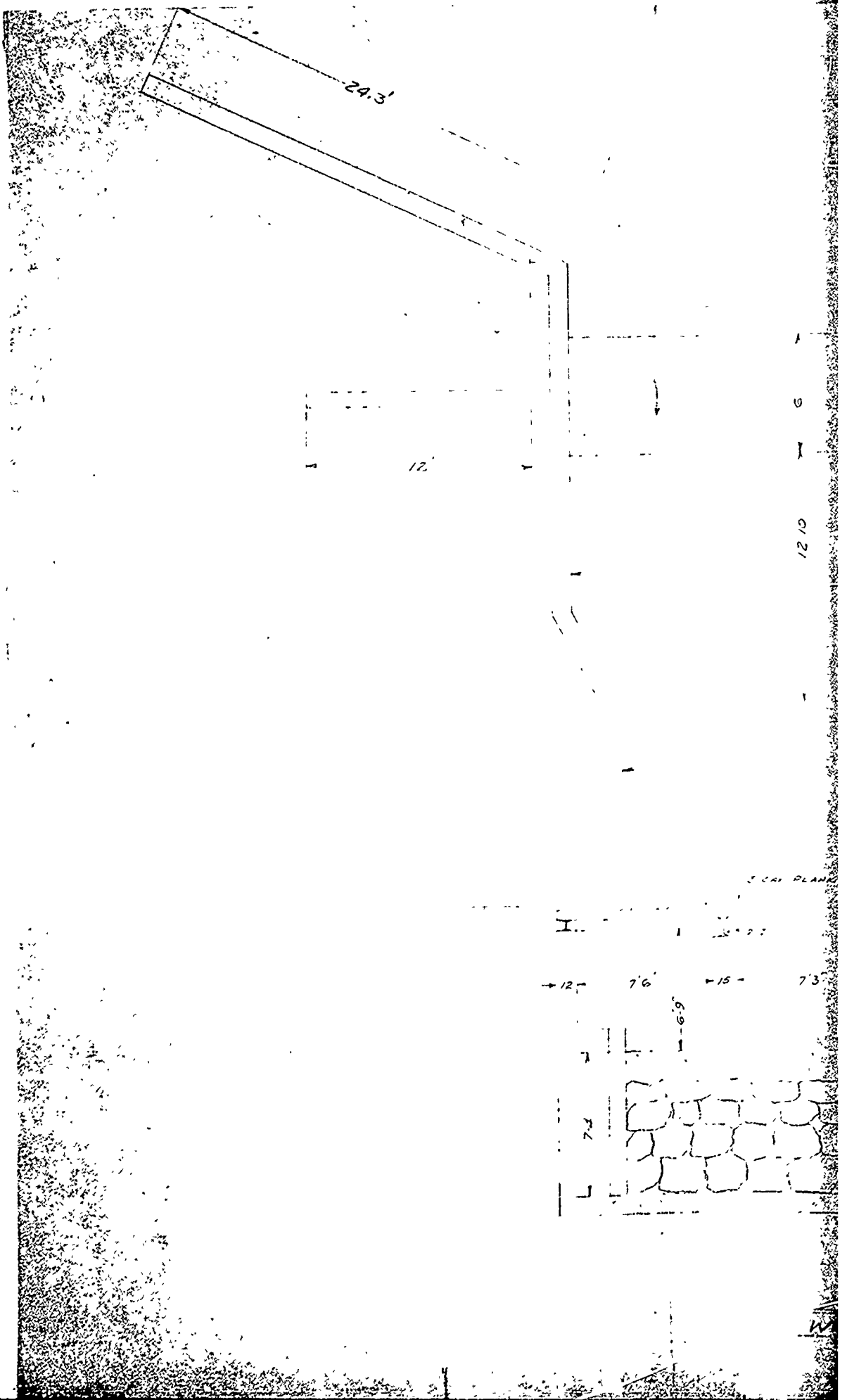
TUDINAL SECTION THRU EMBANKMENT
SCALE: 1"=30 FT.

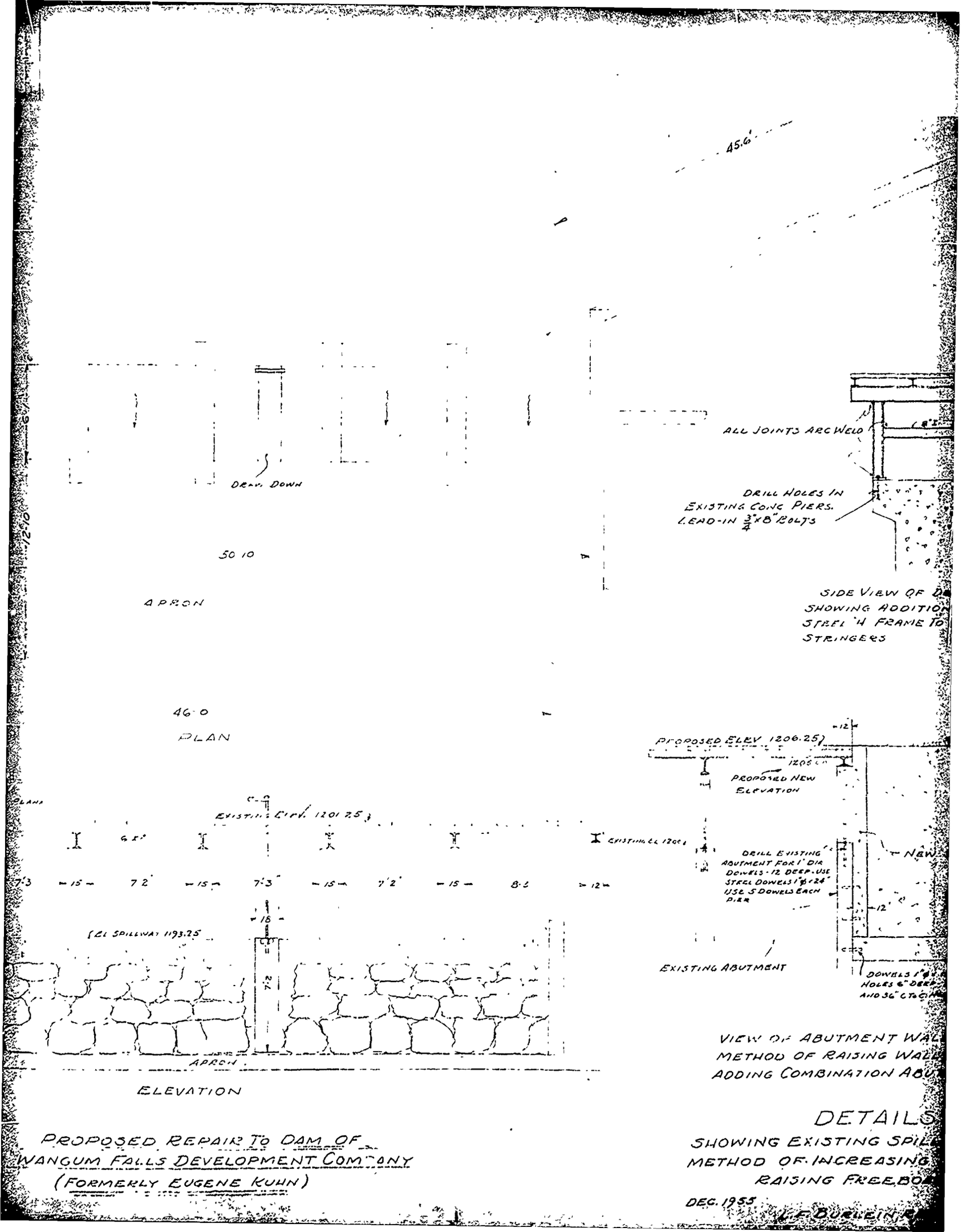
DETAILS
PROPOSED REPAIRS TO DAM OF WANGUM FALLS DEVELOPMENT CO. PAUPACK TWP. WAYNE CO.

FEB 1956 SCALE AS SHOWN

L.L. BURLEIN REG. ENGR.

PA-00141
PLATE III


24.3'
12'
12'-0"
SCALE PLAN
12'
7'6"
15'
7'3"
9'-6"



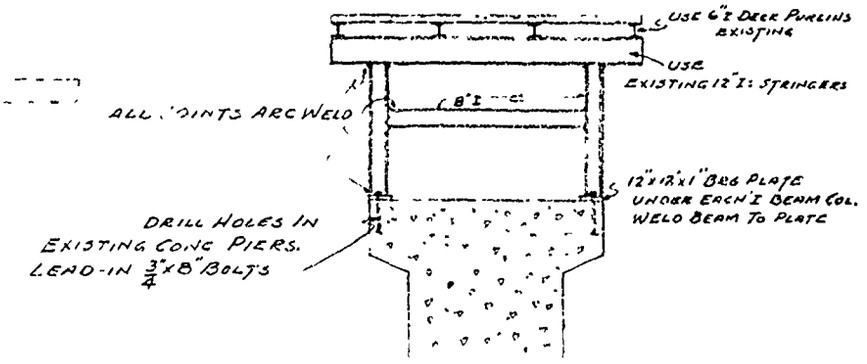
DETAILS

SHOWING EXISTING SPILL
METHOD OF INCREASING
RAISING FREEBO

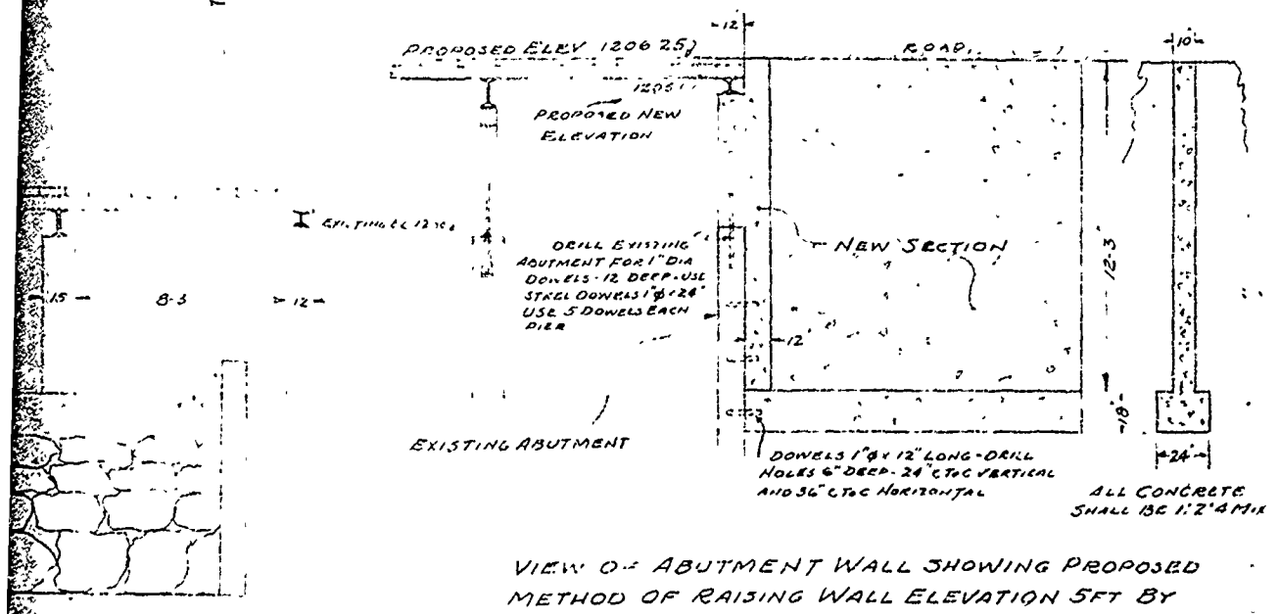
PROPOSED REPAIR TO DAM OF
WANGUM FALLS DEVELOPMENT COMPANY
(FORMERLY EUGENE KUHN)

DEC. 1955

L. F. BURLEIGH



SIDE VIEW OF DECK SUPPORT PIER SHOWING ADDITION OF STRUCTURAL STEEL 'H' FRAME TO CARRY BRIDGE DECK STRINGERS



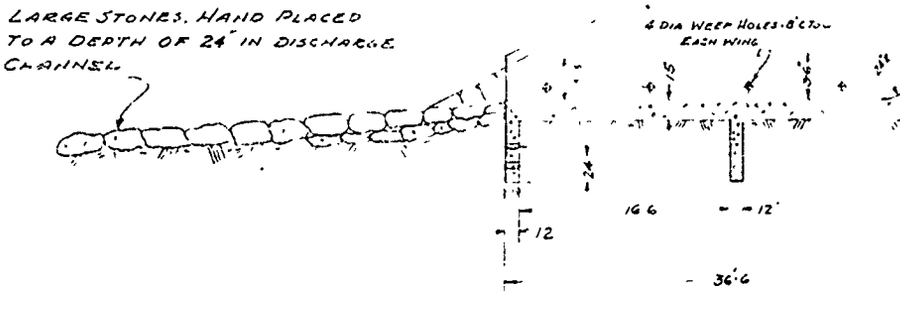
VIEW OF ABUTMENT WALL SHOWING PROPOSED METHOD OF RAISING WALL ELEVATION 5FT BY ADDING COMBINATION ABUTMENT-CUT OFF WALL

DETAILS

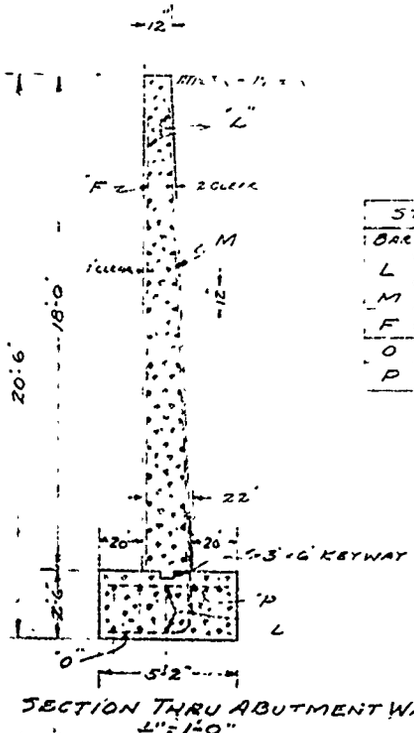
SHOWING EXISTING SPILLWAY AND PROPOSED METHOD OF INCREASING CAPACITY; ALSO RAISING FREEBOARD

DEC 1953 SCALE 1"=1'-0"

PA-00141
PLATE IV

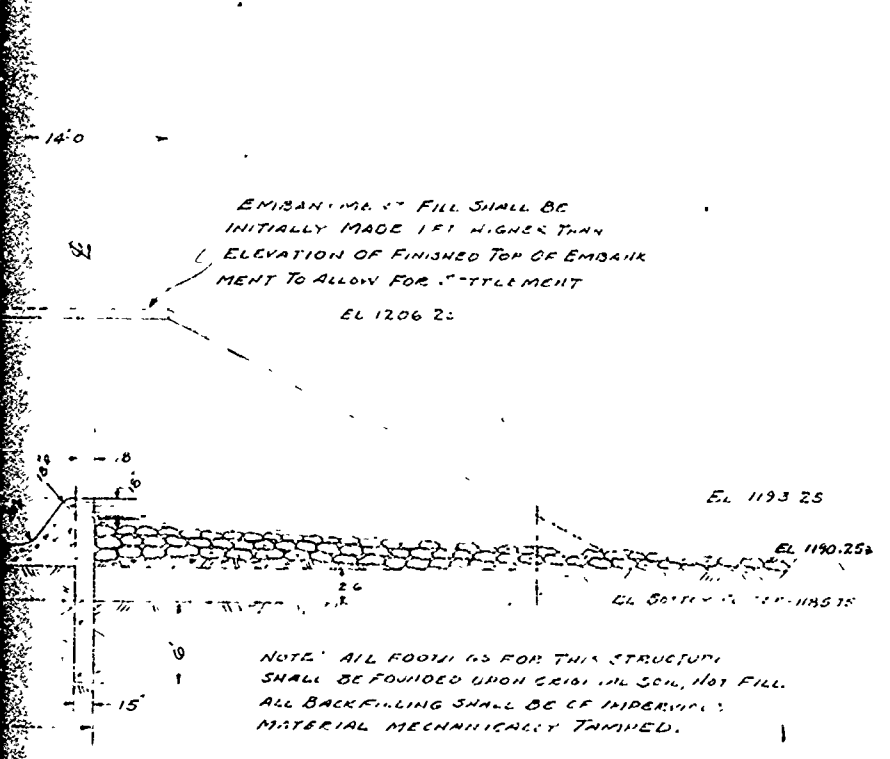


SECTION

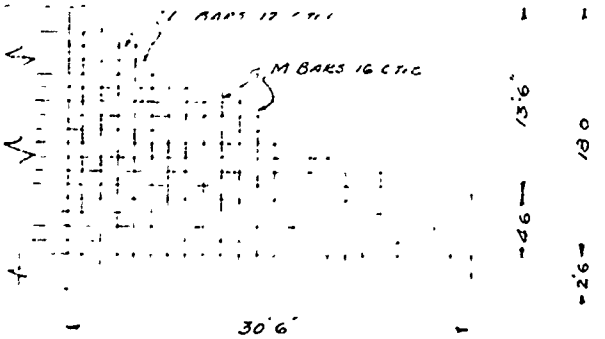


SECTION THRU ABUTMENT WALL

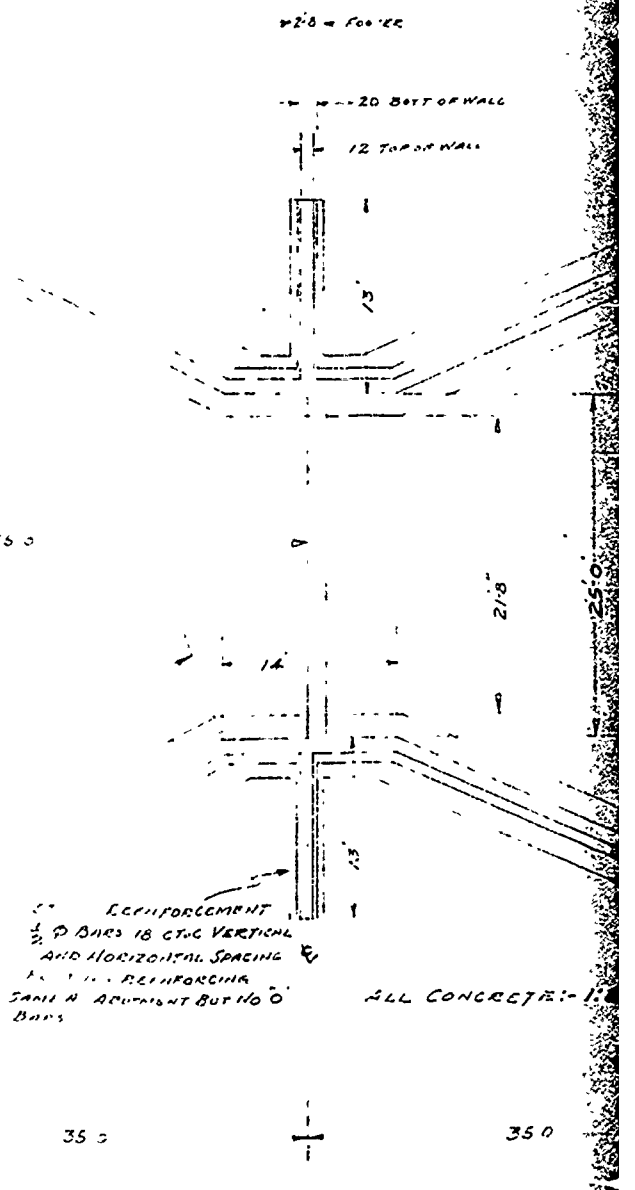
STEEL REENFORCEMENT			
BAR	SIZE	LENGTH	SPACING
L		—	12"
M		18"	18"
F		17'	12"
O		8'-0"	24"
P		4'-6"	16"



N THRU SPILLWAY
1:0



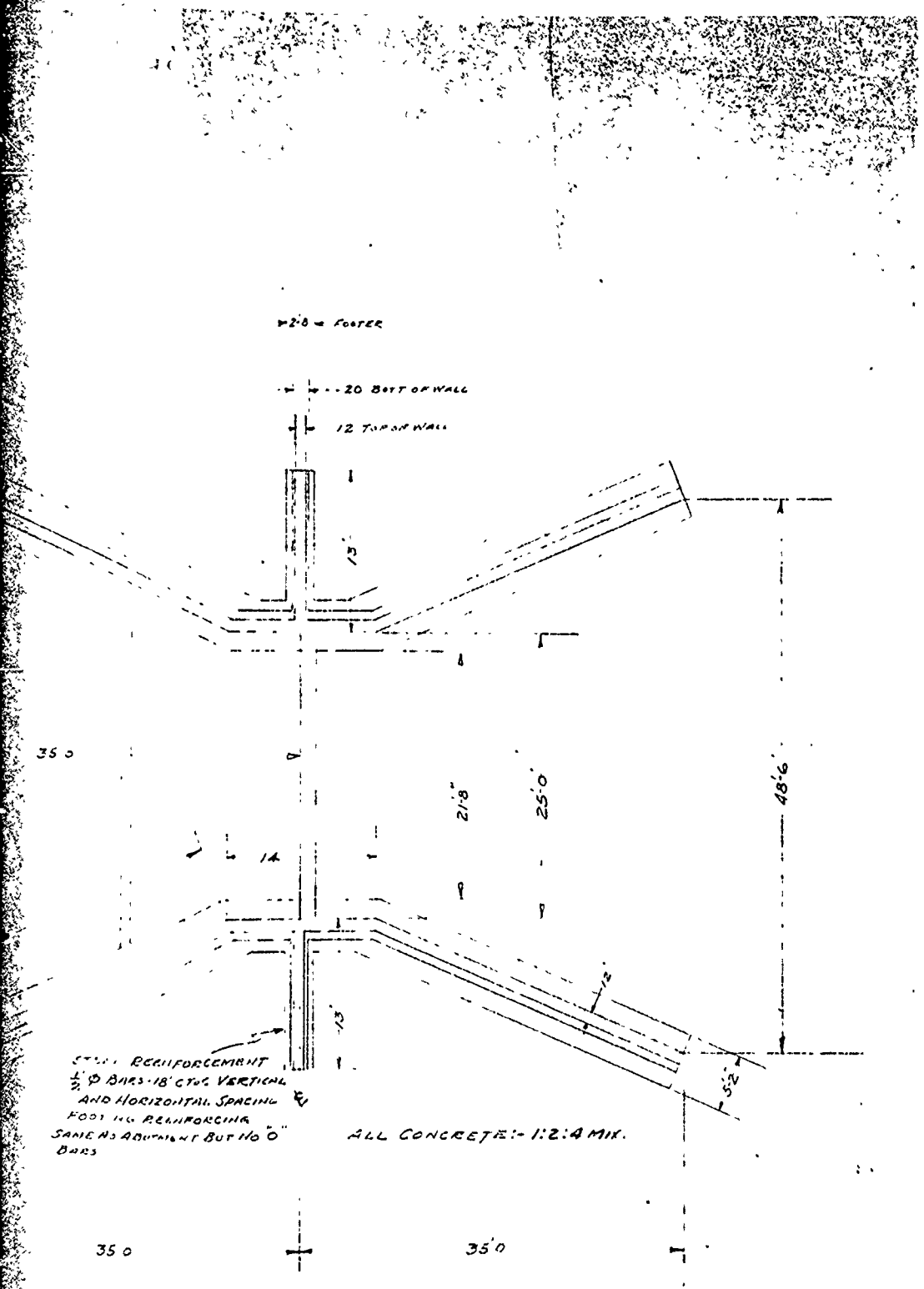
STEEL REENFORCEMENT - WING WALLS
1/8" = 1:0



PLAN
1/8 = 1-0

DETAILS

NEW PROPOSED SPILLWAY TO
TO LAKE OF WANGUM FALLS
CO., (FORMERLY OWNED BY E. K
PAUPACK TSHP. WAYNE CO.
FEB. 1956
L. F. BURLEIN, REG ENGR



PLAN
1/8" = 1-0"

DETAILS

NEW PROPOSED SPILLWAY TO BE ADDED
TO LAKE OF WANGUM FALLS DEVELOPMENT
CO., (FORMERLY OWNED BY E. KUHN).
PALIPACK TSHP. WAYNE CO.
FEB. 1956
L. F. BURLLIN, REG ENGR

PA-00141
PLATE V

APPENDIX F

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Catskill Formation, undifferentiated.

Lithology: Grayish red to greenish gray and mottled red-gray siltstone, interbedded with silty shale and fine sandstone.

Structure

The site is within the Pocono Plateau area and the beds are essentially horizontal.

Air photo fracture traces trend: N70°W, N10°W, N20°W, N30°E N25°E, and N15°E.

Overburden

This is an old dam, rebuilt in 1926, and again in 1956. Very little foundation information is available. The site is within the limits of Pleistocene galciation and thin deposits of ground morraine till are present in the area. Glacial outwash consisting of sand, gravel and silt is present in the valley of Wangaum Creek.

Aquifer Characteristics

The rocks of the Catskill Formation are essentially impermeable, ground water moves entirely along bedding planes and fractures. The strong expression of fractures seen on the air photos suggests that there is considerable ground water movement in these fractures here. However, the most permeable aquifers in the area are the sands and gravels present in the stream valleys.

Discussion

Leakage was reported at the right side of the dam and at the center of the toe in 1931. This leakage increased and repairs were requested in 1938. These leaks were probably, in part, under the dam, in the valley alluvium, or through bedrock fractures. The dam was repaired after being breached in 1955. The new spillway on the right side was founded on rock and a four foot deep cut-off trench is indicated on the upstream side of the spillway. There is the possibility of water movement through fractures beneath this cut-off trench. There is also the possibility of leakage under the central part of the dam, through alluvium that may be present there.

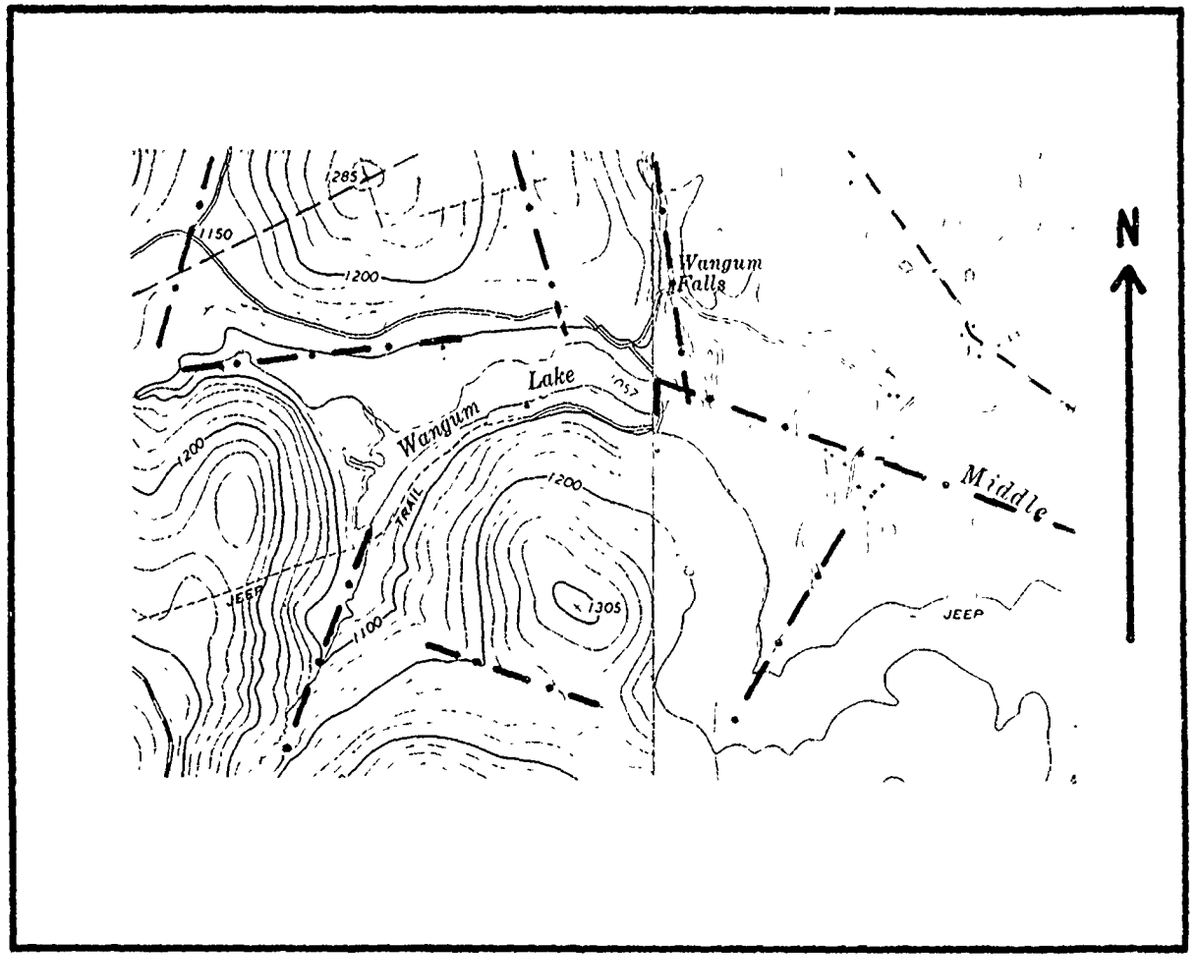
Sources of Information

1. Manuscript Geologic Maps of the Waymart and Howley Quadrangles, open file, Pa. Geological Survey, Harrisburg, Pa.

2. Inspection reports on file.

3. Air photographs. Scale, 1:20,000. Dated 1966.

GEOLOGIC MAP - Wangum Falls Dam



key

Dck — Catskill Fm. - undifferentiated

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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET